FUNDAMENTALS OF DATA COMMUNICATIONS AND LOCAL AREA NETWORKS

SEMINAR WORKBOOK

DATA-TECH INSTITUTE

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SEMINAR_____LOCATION _____ DATE_____INSTRUCTOR _____

NAME_____TITLE_____

COMPANY _____ CITY _____

1. FUNCTION (AREAS OF RESPONSIBILITY)

2. WHAT DO YOU EXPECT TO LEARN IN THIS SEMINAR?

3. PLEASE CHOOSE SEVERAL TOPICS FROM THE TABLE OF CONTENTS IN THE SEMINAR WORKBOOK AND PRIORITIZE REGARDING IMPORTANCE TO YOU TO BE EMPHASIZED DURING THE SEMINAR.

4. WHY IS THIS TRAINING IMPORTANT TO YOU AND YOUR ORGANIZATION?

5. HOW WOULD YOU CATEGORIZE YOUR CURRENT UNDERSTANDING/KNOWLEDGE OF THE SUBJECT?

FUNDAMENTALS OF DATA COMMUNICATIONS AND LOCAL AREA NETWORKS

COURSE TOPICS

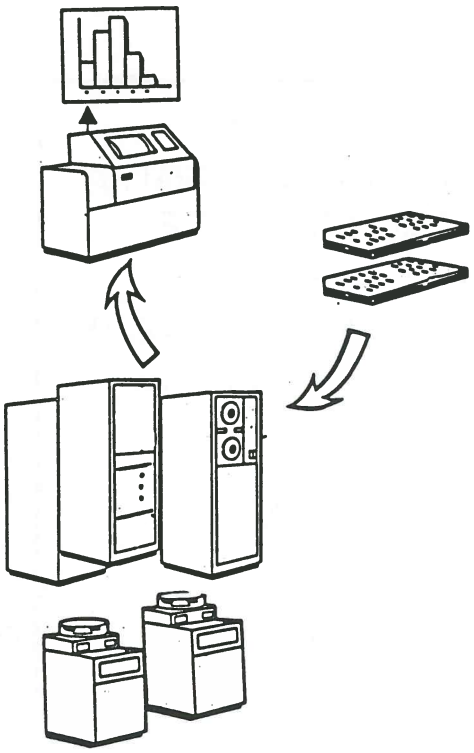
SECTION:

SECTION 1.0

DATA COMMUNICATIONS

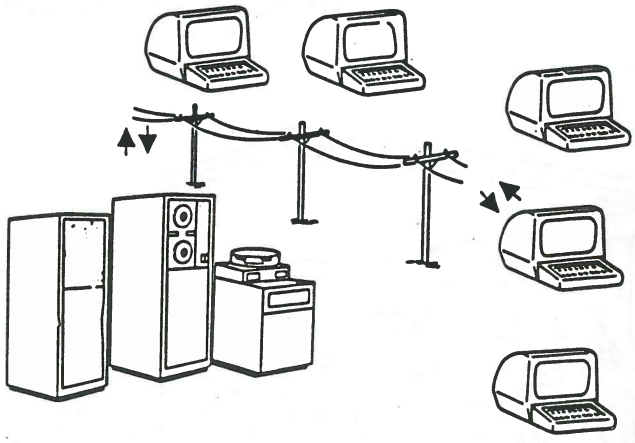
CONCEPTS AND COMPONENTS

LOCAL AREA NETWORK EVOLUTION



BATCH PROCESSING

EARLY ON, IN THE 1950s USERS BROUGHT THEIR JOBS TO THE MACHINE TO BE RUN - THEY DID NOT INTERACT DIRECTLY WITH THE PROGRAMS. NO DIRECT COMMUNICATIONS WAS INVOLVED.

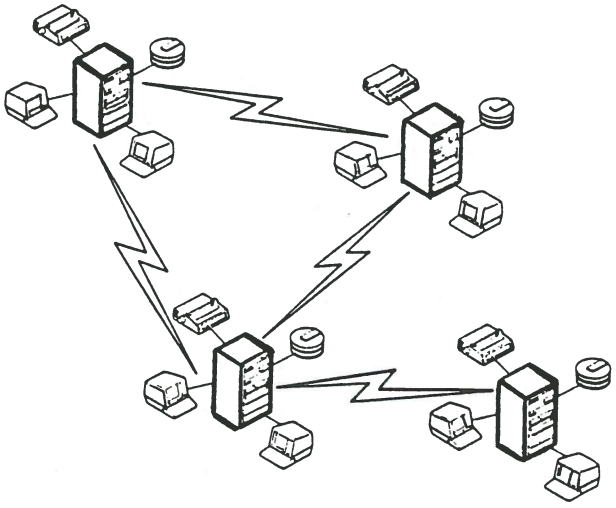


MAINFRAME INTERACTIVE/TIME SHARING

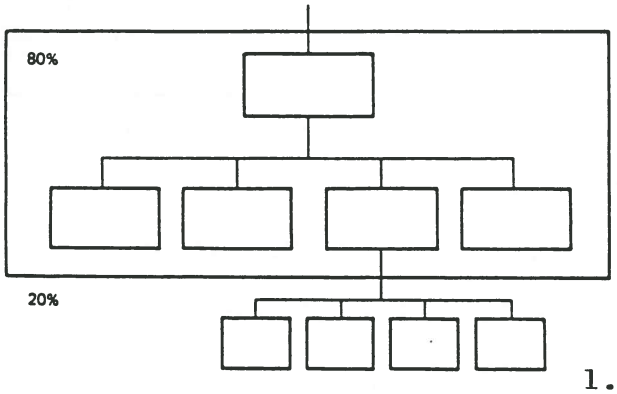
BY THE 1960s, TIMESHARING ALLOWED INTERACTION WITH THE COMPUTER USING TELETYPEWRITER AND DATA TRANSMISSION TECHNOLOGIES. THIS ADVANCED TO INTERACTIVE PROGRAMS THAT "TALKED" TO THE USER THROUGH MORE ADVANCED TERMINALS.

DURING THE 1970s THE USE OF VERSATILE AND INEXPENSIVE MINI-COMPUTERS GREW AS USERS DEMANDED COMPUTING POWER WHERE THE WORK WAS BEING PERFORMED. USERS BEGAN TO SHARE FILES, PROGRAMS, STORAGE AND DEVICES LEADING TO EARLY DISTRIBUTED PROCESSING APPLICATIONS.

DISTRIBUTED PROCESSING

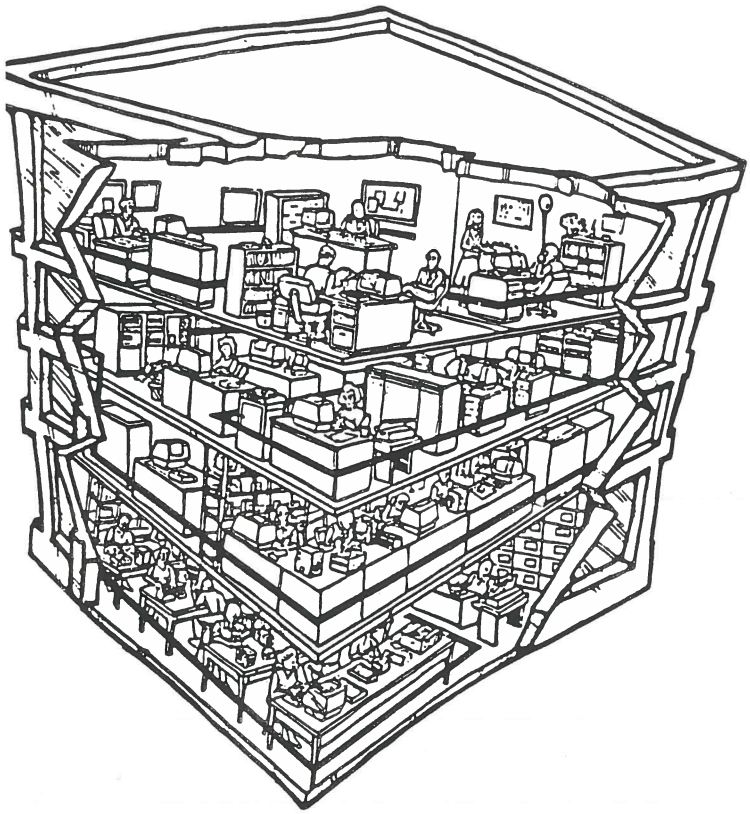


80% OF THE INFORMATION USED COMES FROM WITHIN THE ENVIRONMENT.



80/20 RULE!

NEED FOR INTEGRATED LOCAL COMMUNICATIONS



- 1980s SHOW RESULTS OF VERY LARGE SCALE INTEGRATION (VLSI) TECHNOLOGY IN THE PERSONAL COMPUTER.
- ADVANTAGES IN NETWORKING IN AND AROUND THE OFFICE FOR LOCAL:
  - DATA PROCESSING
  - DATABASE MANAGEMENT
  - PROCESS CONTROL
  - TYPESETTING
  - WORD PROCESSING
  - ELECTRONIC MAIL
  - SHARING OF RESOURCES

STATEGIC VALUE OF NETWORKS

INFLUENCE (ECONOMIC)
INTEGRATION OF PROCESSES
INFORMATION AVAILABILITY
INTERCONNECTION/SHARING
INTERCOMMUNICATIONS
INTERRELATIONSHIPS

BUSINESS ARGUMENTS FOR LANS

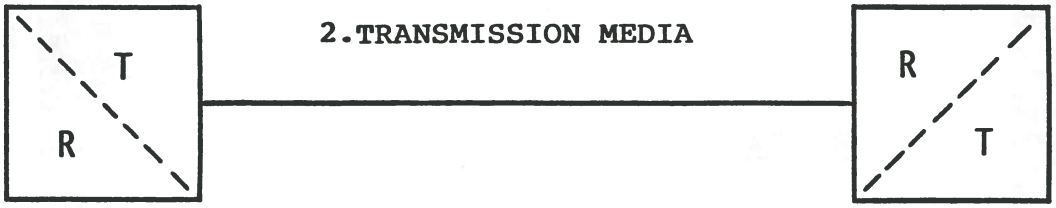
INTERCONNECTION	FLEXIBILITY
INTEGRATION	SHARING RESOURCES
CONTROL	SUPLEMENTAL
ECONOMY	VALUES (NON-DATA USES)
UTILITY	
STABILITY	STRATEGIC VALUE

OBJECTIVES

- IMPROVE PRODUCTIVITY THROUGH MORE AUTOMATION OF ROUTINE FUNCTIONS.
- IMPROVE MANAGEABILITY OF INFORMATION THROUGH REDUCED DUPLICATION AND IMPROVED ACCESSIBILITY.
- IMPROVE EMPLOYEE INTERACTION THROUGH SHARING OF INFORMATION.
- REDUCE OR CONTROL COSTS BY USING COST EFFECTIVE COMMUNICATIONS.
- COOPERATIVE PROCESSING BETWEEN PERSONAL COMPUTERS AND MAINFRAMES.
- STANDARDIZE COMPUTER AND COMMUNICATIONS USAGE.

THE BASIC ELEMENTS

1.TRANSMITTER/RECEIVER



TRANSMITTER/RECEIVER

DTE ····· DATA TERMINAL EQUIPMENT ····· DTE

3. "SIGNALS"

A-B-C-D-E-F-G-H-I-J-K-L-M-N-O-P

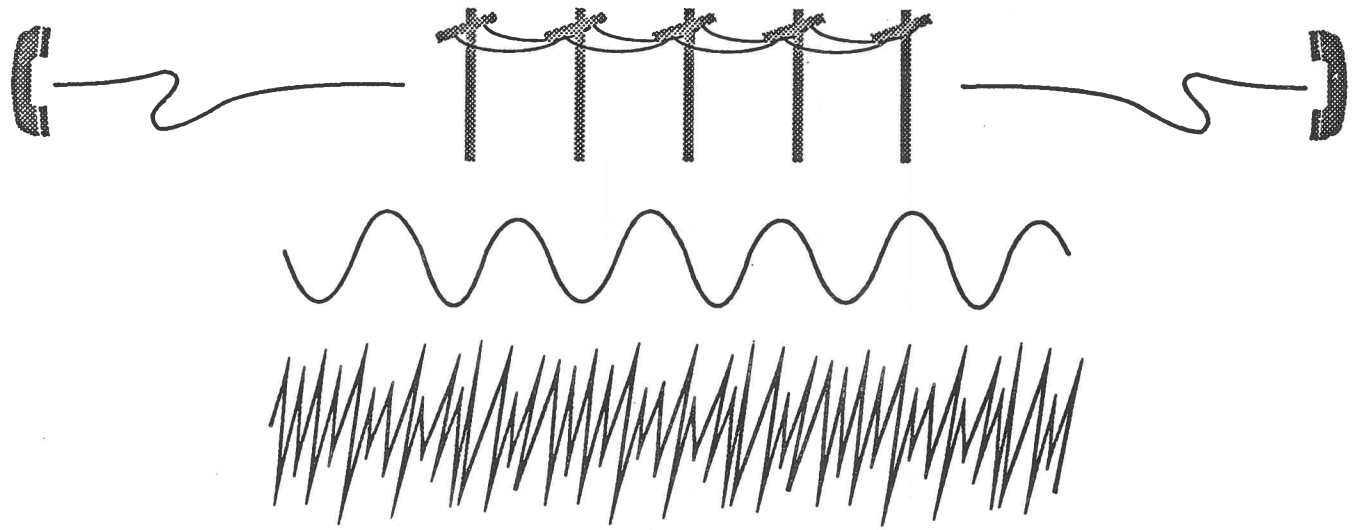
4. "CODES"

5. "PROTOCOLS"

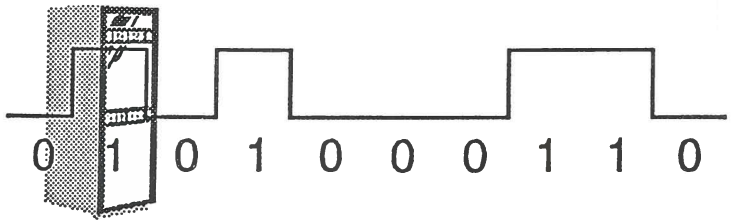
6."ARCHITECTURES"

BATCH DTE	INTELLIGENT DTE	INTERACTIVE DTE
PRINTER	MICROCOMPUTER	PERSONAL COMPUTER
RJE	MINICOMPUTER	"TERMINAL"
FILE TRANSFER	MAINFRAME	3270
TAPE TRANSFER	FRONT-END PROCESSOR	
REPORT TRANSFER		
		TTY
		VT100
		ADM3
		IBM 3101
		IBM 2740

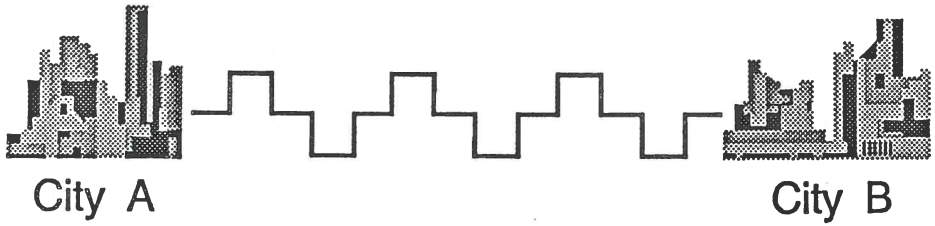
Analog and Digital Transmission



Analog Signals



Digital Equipment Signals



Telephone Company Digital

ANALOG AND DIGITAL TRANSMISSION FACILITIES

There are three signalling methods that should be understood: ANALOG, UNIPOLAR DIGITAL, and BIPOLAR DIGITAL.

An analog signal is a continuous wave of energy which carries information on every part of the wave. A good example of analog is sound waves passing through air. The same sound, if converted to an equivalent electrical signal can be passed through a wire. The original telephone network was analog, and a considerable amount of it remains so today. Most of the diagrams in this book will represent an analog electrical signal as a simple sine wave; however, an actual voice, video, or modem-data signal is much more complex.

The voice band analog facilities obtained from the telephone company, both private line and dial-up, are limited in terms of the electrical properties supported. For example, the range of frequencies that are allowed to pass over these lines is between 300 hz (hertz or cycles per second) and 3300 hz. This yields a BANDWIDTH of the difference or 3000 hz. There are about a dozen more properties that describe how the line operates. These are the specifications of the circuit and can be found in telephone company technical specification manuals. Analog lines have no data speed restrictions only electrical properties. They are bandwidth restricted. Modems (described later) are used to send data over these lines in accordance with these specifications.

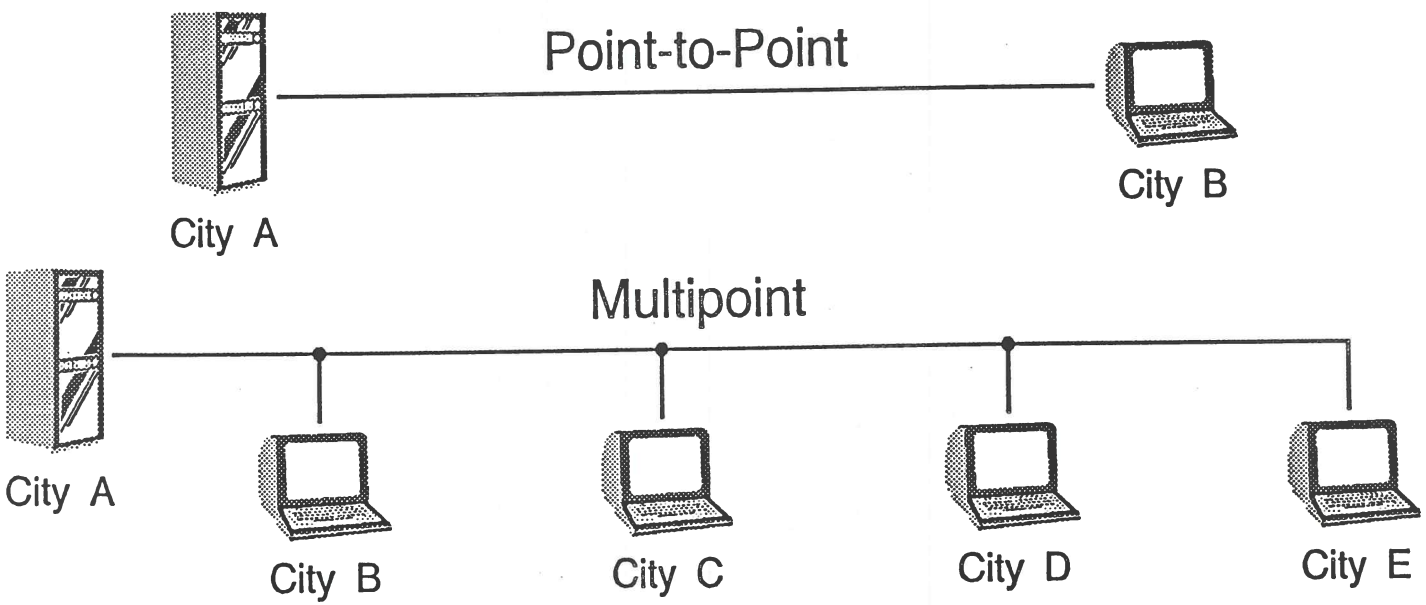
Computers and other such equipment use on and off pulses of electricity to communicate internally, with a binary 1 and 0 logically representing these on and off states. In such hardware these are implemented by very short pulses at a level of about zero volts (logical 0) or about 4.0 volts (logical 1). This format is called digital signalling, specifically using UNIPOLAR digital format.

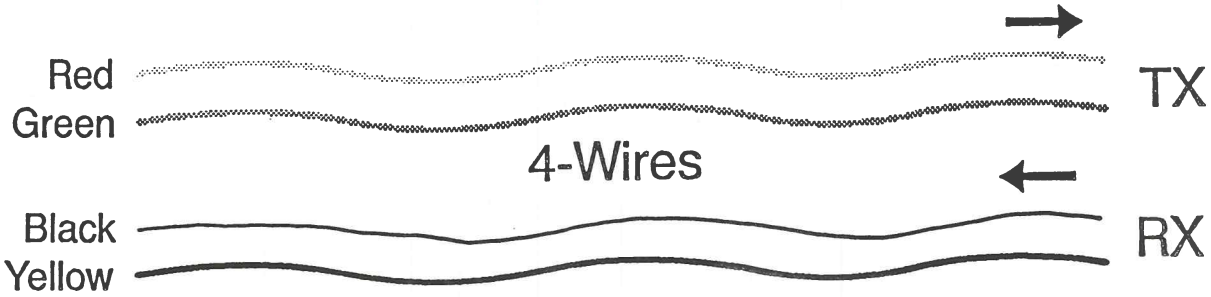
BIPOLAR digital format is better suited for transmission over long distances. Bipolar means that some of the pulses alternate between positive and negative voltages, or logical 1, and a zero voltage level, or logical 0. This is called ALTERNATE MARK INVERSION signalling.

Telephone companies have offered digital transmission lines since the early 1970s as an alternative to analog lines. AT&T's popular DDS (Dataphone Digital Service) and T1 CARRIERS are examples. Digital transmission usually provides a much higher quality transmission compared to analog. All signals must be regenerated every mile or so due to line resistance. Digital repeaters in the network filter out noise; however, the analog network uses amplifiers which carry the noise to the end.

Private Lines

Permanent Connections





TELEPHONE COMPANY PRIVATE LINES

When a remote computer connection is required, especially one that is outside of the building that houses the mainframe or other computer, the most common transmission media used is a telephone circuit. Private lines are one type of telephone circuit and the telephone company is the most common utility company that supplies many such types of circuits.

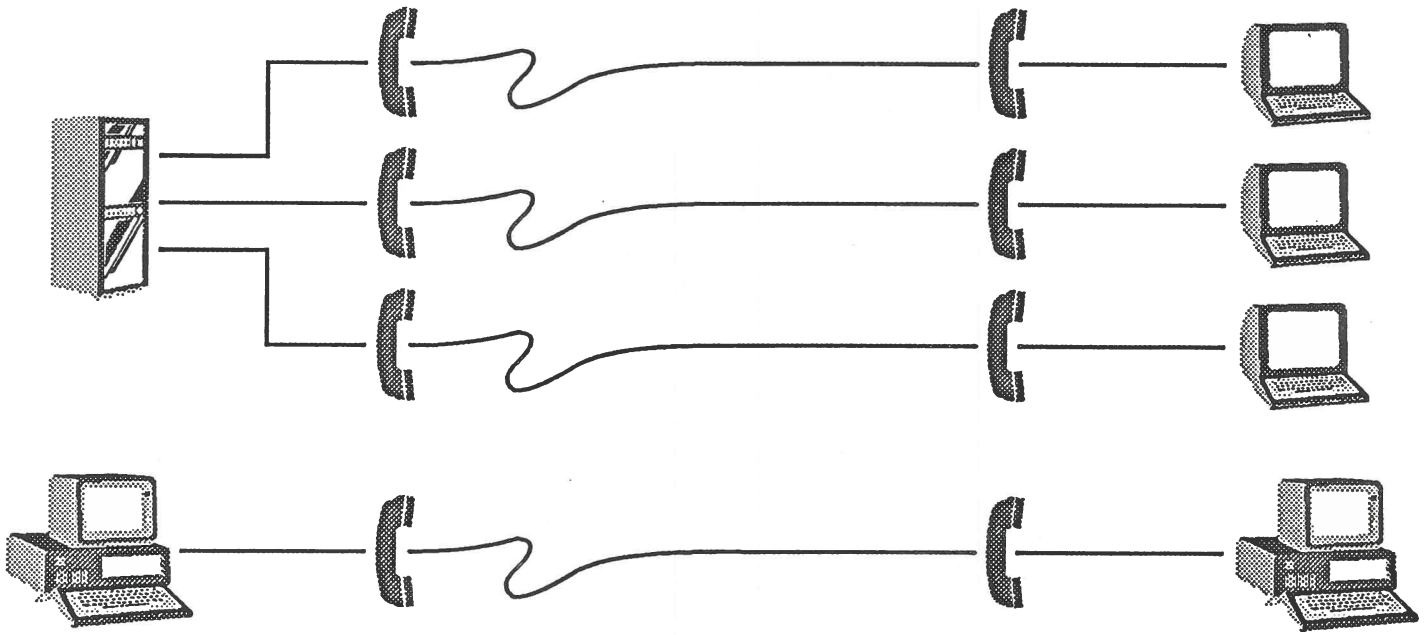
One can think of a private line as a wire running across the nation between two buildings, although they are not implemented as such. They are called private because they are not shared by any other user and are dedicated to the exclusive and full time use by the ordering company. They are rented or leased from the telephone company and are often called LEASED or DEDICATED lines. The rental rate is a monthly charge based upon a milage-based formula plus a fixed charge for the end connections and any special services and a one-time installation charge. The components of private lines and the differences between local, intrastate, and interstate services as well as local and long distance telephone companies are the reason for price variations.

The use of private lines is not limited in terms of how often or how much data can be transmitted each month. However, there maybe some transmission speed limitations depending upon the service selected. ANALOG transmission lines have limitations as to the type, frequency, and strength of signals sent across which directly impact the quality of received data and the maximum speed of data transmission. Analog is universally available. DIGITAL transmission lines are offerred by the telephone company in four to five separate speeds to approximately 300 cities.

Physically a private line is a path through the telephone company's network dedicated to the ordering company. At each company location the private line enters the building as four telephone wires which connect to a jack, Main Distribution Frame, or other termination point, which are called DEMARCATION points. This is the legal separation between the telephone company's equipment and the building owner's inside wire. One pair of the wires, the red and green, are for transmitting out and the other pair, black and yellow, are for receiving data. The dedicated path, the two separate pairs, and the pretesting of the circuit by the telephone company all add to the generally good transmission quality of private lines. These fall into a category of medium speed transmission services called VOICE-GRADE lines, the original voice network. They are also referred to as type 3002 circuits, which is a technical telephone company categorization. Special very-high speed lines are called WIDEBAND. Very-low speed lines are called SUB-VOICE GRADE, which are used more for fire alarm or buglar alarm connections or for other signalling purposes.

Dial-Up Circuits

Temporary Connections
All Point-to-Point



2-Wires

TELEPHONE COMPANY DIAL-UP CIRCUITS

Another commonly used type of circuit obtained from the telephone company is the dial-up circuit, which is the same standard way we make a local or long distance call. This is a type of SWITCHED SERVICE because of the way the telephone company implements the call. When a telephone number is dialed the number is passed through a series of telephone company offices using special connecting circuits called trunk lines to the ultimate destination. This switching action creates a temporary link which is used by the caller for voice or data transmission. When the caller hangs up, the link is broken and the circuit parts are used later for another call between two different locations.

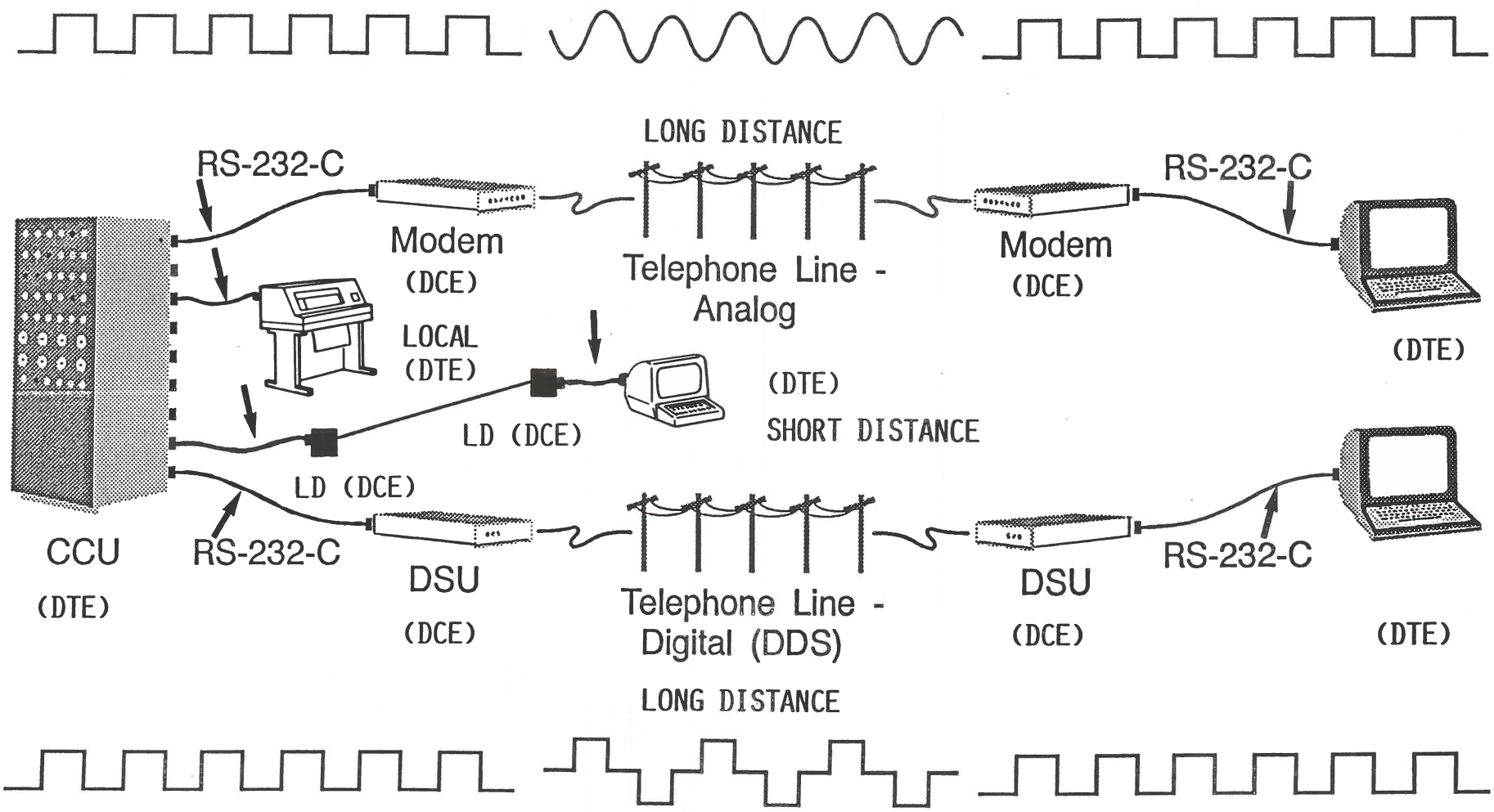
A dial-up circuit by its nature can only act as a point-to-point (one to another) data circuit. Because it is an analog service, modems are used at both end; however, dial-up modems are different from private line modems as they can connect to the TWO-WIRE CIRCUIT and often have automatic dialing and answering capabilities.

As we are all aware, dial-up calls are priced based upon the distance of the call, the length of the call, and the time of day. Businesses can often use discounted service as they are heavy users of dial-up for voice or data.

Physically, a dial-up circuit is a temporary path through the telephone company's network. The connection to that network is a single pair of wires, one red and one green, from a building or house to the nearest telephone company office. It has basically the same electrical characteristics as an analog private line; however, because it is constructed as a series of temporary lines and connections its average quality is often much lower than private lines. Also, the more rural the location the more signal degradation in the links. This translates into more data errors. It is generally the lowest quality type of circuit used, but this factor is highly dependent upon the actual physical properties of the telephone company links which vary from location to location. Because of this quality issue, high speed transmissions are difficult and in some extreme situation, establishing a data call even at low speed may take many tries. As dial-up paths may be implemented on different physical links, a new call to the same number may result in obtaining a better quality connection.

Dial-up is advantageous for use with applications that call for low connect time, low to medium data traffic requirements, and/or where many locations must be reached.

Common Connectors and Interfaces



COMMON CONNECTORS AND INTERFACES

Data signals coming from data communications equipment, such as terminals, processors, and personal computers are in a unipolar format with low output voltage. In order to use common transmission media, such as analog or digital lines, they must be converted to the proper signal format for transmission over long distances.

When using analog dial-up or private lines, the conversion device is called a MODEM, which is short for MOdulator/DEModulator. Modulation means change, which is what a modem does - change the signal format. A modem is required at each end of the circuit and is able to change the signal from digital to analog or from analog to digital depending upon the signal direction. The speed of the modem is the speed at which data is sent out over the analog line as the analog circuit itself does not have a speed component only operating specifications.

A DSU (Data Service Unit) is required when digital, DDS private lines are used. The DSU converts from unipolar to bipolar digital, provides the terminal device with timing information, and assists with network testing at the proper speeds. Digital DDS service is offered at 2400, 4800, 9600, 56,000 and now 19,200 bps (BITS PER SECOND).

In data communications, transmission rate is specified in terms of the number of bits that are transmitted per second.

Whenever terminal or digital equipment is connected to data communications equipment, such as modems and DSUs, the common interface used in the United States is called the RS-232-C INTERFACE. This refers to special cable and controlling logic in the equipment. It was developed by the Electronics Industry Association (EIA) and is often called the EIA INTERFACE. Related to this is the RS-449 and RS-232-D (revision D). For high speed interfaces, above 19,200 bps, another standard called the V.35 INTERFACE is used. This comes from an international standards group.

Telephone lines can be connected to the modems through the use of four-wire lug connections or modular plugs/jacks. The most popular dial-up line connector is called the RJ11-C, which is the small box on the wall into which a telephone jack is plugged. This is also a common line interface for dial-up modems. However, some dial-up modems come with special 6-wire or 8-wire plugs which need RJ41 or RJ45-S connectors. These boxes have extra electronics in them which, when combined with the modem electronics, causes stronger signals to be sent from the modem to the telephone company office. These jacks are put in by the telephone company and set to certain levels.

COMMON TRANSMISSION SPEEDS

bps - BITS PER SECOND.... dependant upon the DTE, DCE and transmission media capabilities.

ANALOG
(Voice Grade Lines)
(TYPE 3002 CIRCUIT)

ANALOG VOICE GRADE IS A STANDARD CATEGORY OF LINE. IT IS DEFINED BY ELECTRICAL OPERATIONAL PARAMETERS AS DEFINED IN AT&T'S TECHNICAL REFERENCE MANUAL 41004 AND IS NOT SPEED DEPENDENT. SPEED IS PROVIDED BY MODEMS.

300 bps	DIAL CAPABLE
1200 "	"
2400 "	"
4800 "	"
9600 "	"
19200 "	PRIVATE LINE
24000 "	"

DIGITAL
(AT&T's DDS Line)

DATAPHONE DIGITAL SERVICE (DDS) IS OFFERED BY AT&T AT SPECIFIC TRANSMISSION RATES INTO THE CUSTOMER'S PREMISE. IT IS DEFINED BY AT&T TECHNICAL REFERENCE 41021.

DDS 1	DDS 2
2400 bps	PLUS DIAGNOSTIC CHANNEL
4800 "	.
9600 "	.
19200 "	.
56000 "	.

(SWITCHED 56,000 AND SWITCHED T1 AVAILABLE)

DIGITAL CARRIER HIERARCHY

Signal Level	Rate	Voice Channels	Carrier System
DS-0	64 K bps	1	None
DS-1	1.544 M bps	24	T-1
DS-1C	3.152 M bps	48	T-1C
DS-2	6.312 M bps	96	T-2
DS-3	44.736 M bps	672	T-3
DS-4	274.176 M bps	4032	T-4

SHORT DISTANCE COMMUNICATIONS

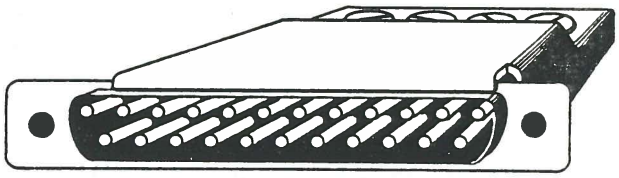
RS-232 SPECIFICATION:

UP TO 19,200 bps @ 50 FEET

CAPABILITY WITH GOOD UNSHIELDED TWISTED PAIR (UTP)

9600 bps @ 1200 FEET

19,200 bps @ 800 FEET

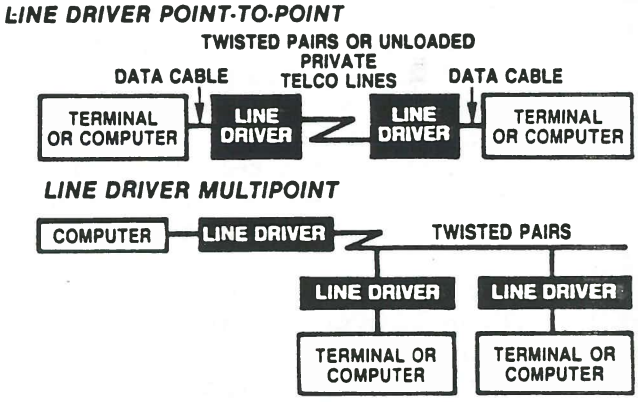


LINE DRIVERS:

4-WIRE 56,000 bps Async
@ 1 Mile .....$ 95.00

4-WIRE 9600 BPS Async
@ 3 Miles .....$ 70.00

2-WIRE 9600 bps Async
@ 1 K meter.....$ 70.00



SHORT HAUL MODEMS:

2-WIRE 19,200 bps
@ 7 Miles $195.00

2-WIRE 19,200 bps Sync/Async
@ 3-5 Miles $300.00

4-WIRE 100,000 bps
@ <1 Mile $195.00

FIBER (LIGHT) DRIVERS:

2-FIBER 19,200 bps
@ 2 K Meters $100.00

2-FIBER 10 M bps
@ 1.25 Miles $355.00

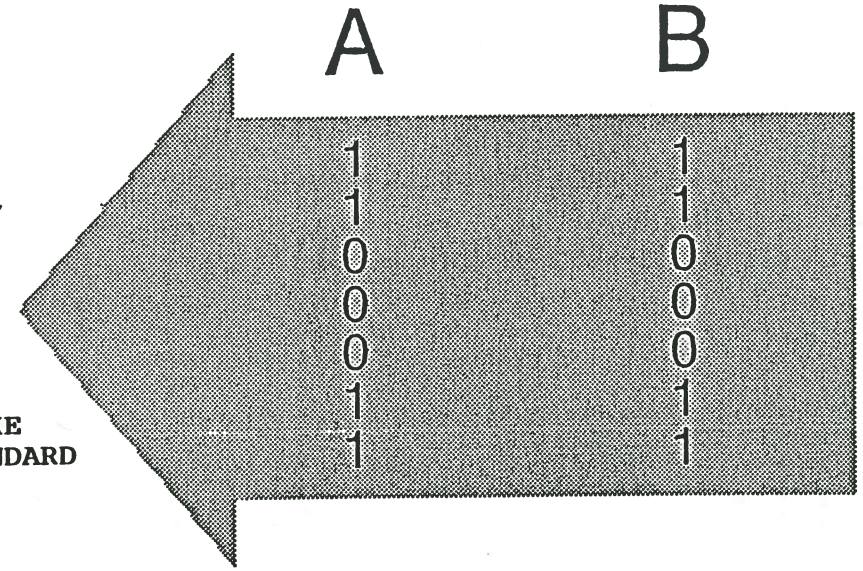
SHORTHAUL MODEMS AND LINE DRIVERS

Short-haul communications devices are advisable or necessary when cable lengths between RS-232 interface devices begin to exceed several hundred feet at 9600 bps. While extended distance data cable for up to 500 feet or more is available, such RS-232 cable is expensive and bulky, and in the synchronous case a modem eliminator would still be required. Short-haul products are generally designed to be used with inexpensive 2 and 4-wire unshielded twisted pair or in some cases ordinary in-house telephone wire. Depending on the type of wire used, its diameter, twists per foot, shielding and electrical impedance distances few thousand feet to several miles are possible. Range depends more on the data rate, mode (half or full duplex) and wire/telephone line than upon the particular brand product chosen. In general, lines that are obtained from a phone company and pass through a Central Office are not suitable for short-haul devices. In some areas it is possible to special-order telephone company lines that have no filters or transformers on them, so the bandwidth of the line is adequate to support the wider frequency spectrum that short-haul devices require, especially at 9600 bps and above. The phone company and FCC require that all signals placed on private-line circuits adhere to part 68 which limit the amount of energy in the frequency band above 3000 hz to prevent interference to subscribers. Meeting this specification usually lowers the range and maximum data rate at which the short-haul product can operate.

Short-haul products come in a variety of types. There are basic line drivers, which are essentially interface converters that change the RS-232 signal levels to a low voltage, low impedance format more suitable to line characteristics. The binary nature of the data is not altered in any way, so line drivers are not code or protocol sensitive. Some line drivers do not require AC power, taking power from signal leads to drive the line. Some asynchronous and virtually all synchronous short-haul units encode data in various ways so that less bandwidth is required to send the data and clock can be recovered from the receive data stream. Other features, such as diagnostic signalling for remote loopback or controlled-carrier (actually, pseudo carrier) are useful in multipoint short-haul networks, and a full-duplex 2-wire capability can save wire at the expense of range.

Bit Transfer Technique

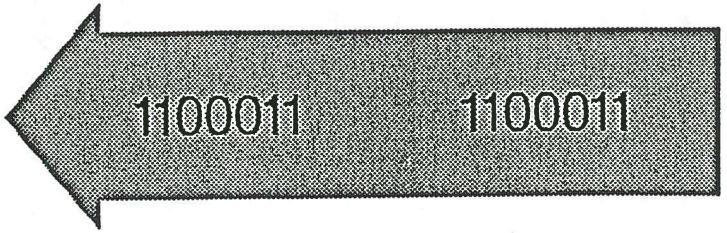
Parallel: Serial by character, parallel by bit



Each bit forwarded over its own subchannel

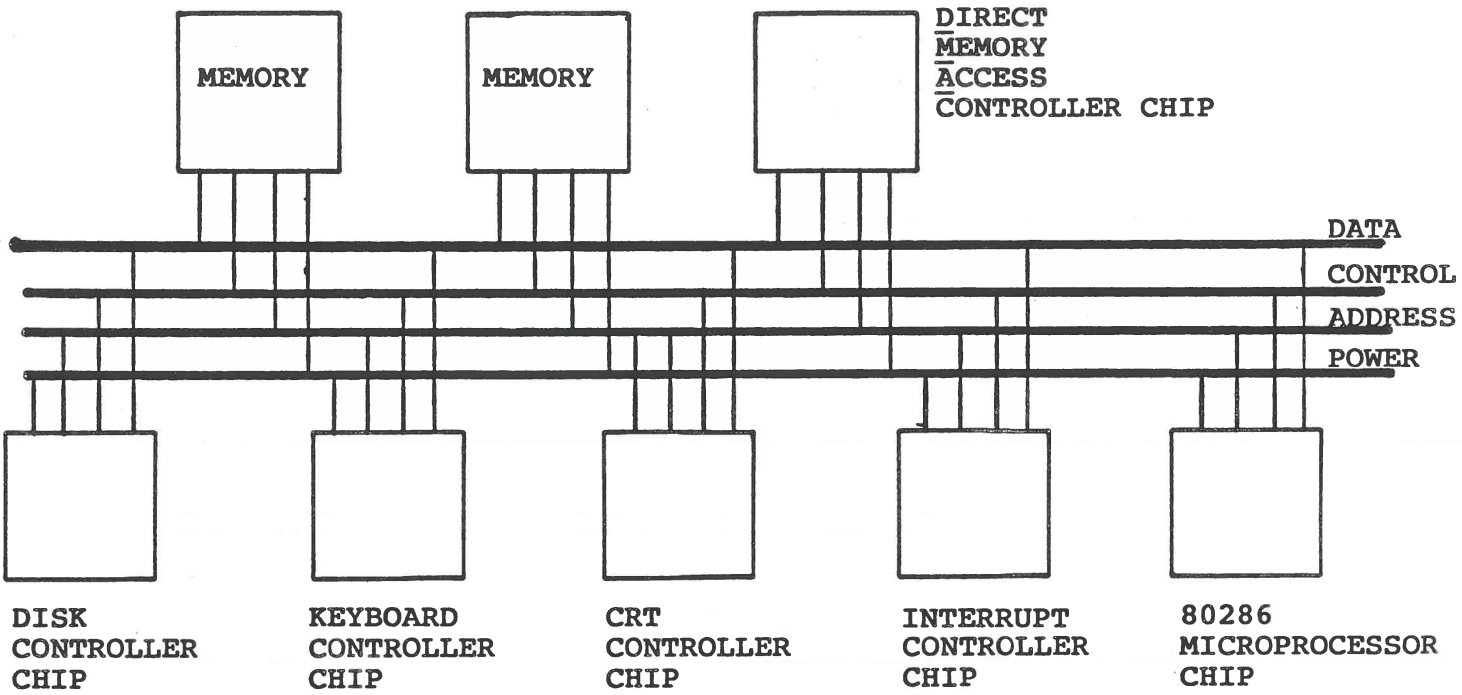
EXAMPLE:
° HARDWARE INTERNAL
° PC LOCAL PRINTERS LIKE CENTRONICS CABLE STANDARD

Serial: Serial by character, serial by bit



EXAMPLE:
° ANY RS-232 INTERFACE TO MODEMS, DSUs, OR LINE DRIVERS

INTERNAL BUS STRUCTURE



LOCATED ALONG THE BUS ARE INPUT AND OUTPUT (I/O) PORTS THAT CONNECT THE VARIOUS MEMORY AND SUPPORT CHIPS AND CARRY INFORMATION TO AND FROM THE CPU (MICROPROCESSOR). THE BUS IS MADE UP OF MANY, MANY WIRE PATHS WHICH ARE DIVIDED INTO FOUR FUNCTION:

DATA BUS - CARRIES THE INFORMATION OVER 8 SIGNAL LINES FOR THE 8088 OR 16 (BIT) LINES FOR 80286/80386.

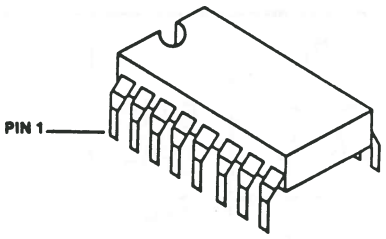
CONTROL BUS - CARRIES CONTROL SIGNALS SUCH AS "READ", "ACCEPT", "TURN ON", ETC. TO COORDINATE THE TRANSFER OF INFORMATION.

ADDRESS BUS - THE MEMORY ADDRESS TO BE READ OR WRITTEN TO IS FIRST SENT DOWN THE BUS FOLLOWED BY THE DATA. THERE ARE 20 SIGNAL LINES USED TO CARRY THE ADDRESS IN THE PC OR 2^{20} = 1,048576 ADDRESS; 24 USED IN THE PC AT = 16,777,216 MEMORY ADDRESSES

REGISTERS IN THE CHIPS TEMPORARILY HOLD DATA, MEMORY ADDRESSES, POINTERS AND STATUS FLAGS WAITING THEIR TURN TO USE THE BUS.

MICROPROCESSOR CHIPS

ALMOST EVERY BIT OF DATA THAT ENTERS OR LEAVES THE COMPUTER PASSES THROUGH THE CENTRAL PROCESSING UNIT (CPU) TO BE PROCESSED OR REDIRECTED.



POPULAR EXAMPLES OF MICROPROCESSORS

INTEL 8088 - 16 BIT WORD, 8 BIT BUS
POPULAR IN IBM PC, XT AND COMPATIBLES

INTEL 8086 - 16 BIT WORD, 16 BIT BUS, 8 MEGAHERTZ (CPS) CLOCK
POPULAR IN COMPAQ DESKPRO
(80186 MORE ADVANCED VERSION)

INTEL 80286 - 16 BIT WORD, 16 BIT BUS, 10 M HZ CLOCK
POPULAR IN PC AT AND COMPATIBLES
ALLOWS MULTITASKING - SEVERAL ACTIVITIES AT ONCE

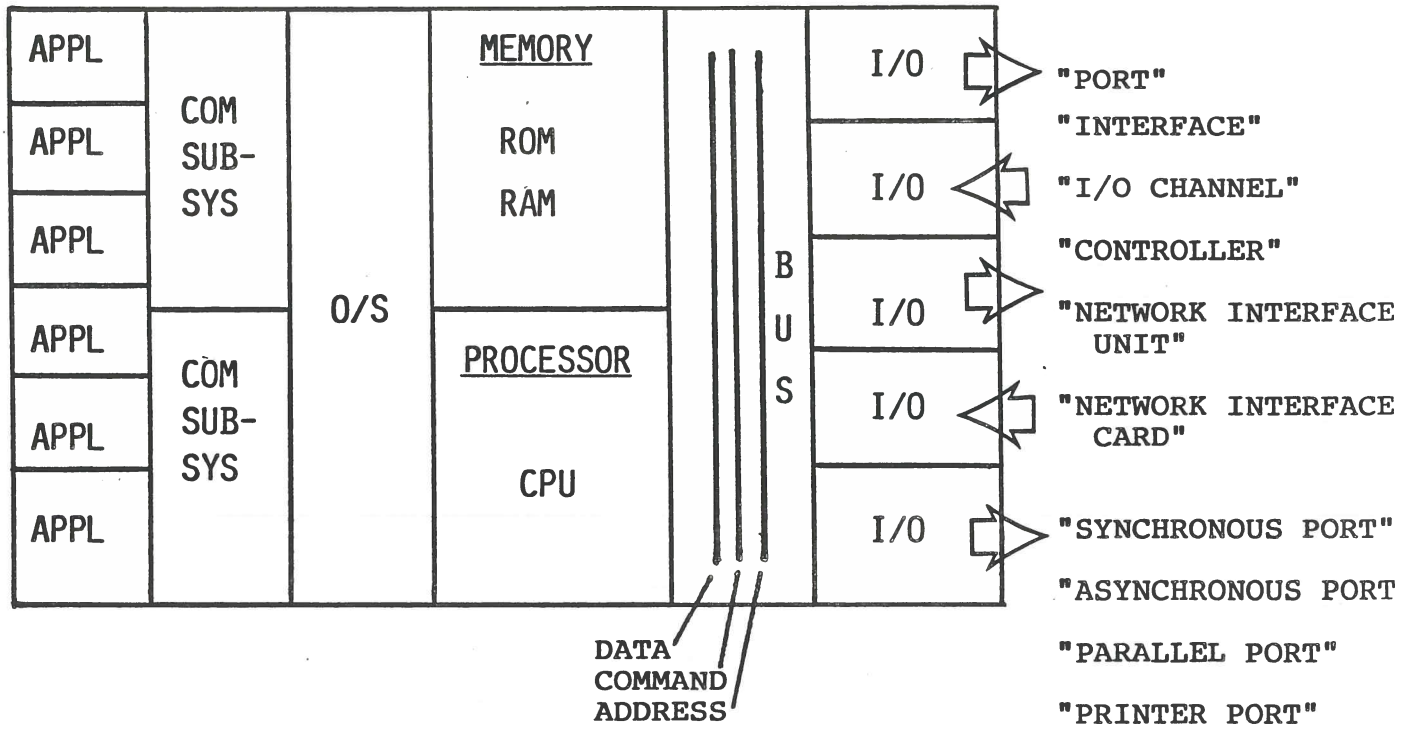
INTEL 8087 - MATH COPROCESSOR: ASSISTS MAIN PROCESSOR WITH THE JOB OB HANDLING FLOATING-POINT NUMBERS (NON-WHOLE NUMBERS) TO SPEED MATH AND SPREAD SHEET OPERATION

INTEL 80386 - 20 TIMES THE COMPONENTS FOUND ON THE 8086, FULL 32 BIT ARCHITECTURE , ALLOWS UP TO 256 CONCURRENT OPERATIONS, 16 M HZ CLOCK
POPULAR IN IBM PS/2 LINE COMPAQ AND COMPATIBLES, CAN ADDRESS UP TO 4 GIGABYTES (4,000 MEGABYTES), FOUR OPERATING MODES: REAL (80860, PROTECTED (80286), NATIVE 80386 (NEW), AND VIRTUAL MODE. VIRTUAL IS LIKE SEVERAL 8086 COMPUTERS EACH ABLE TO ADDRESS ONE MEGABYTE OF MEMORY EACH PROTECTED FROM THE OTHER - LIKE SEVERAL MS-DOS MACHINES IN ONE.

INTEL 80386SX 32 BIT ARCHITECTURE WORD INSIDE BUT 16 BIT BUS TO SUPPORT ADD-ON PRODUCTS DEVELOPED FOR THE 80286, LIKE DISK DRIVES, VIDEO CONTROLLERS AND FAX BOARDS - KEEPS THE SYSTEM PRICE DOWN BUT IT CAN STILL PROCESS AT THE 16 M hz SPEED.

THE MICROPROCESSOR CONTROLS THE COMPUTER'S BASIC OPERATION BY SENDING AND RECEIVING CONTROL SIGNALS, MEMORY ADDRESSES AND DATA FROM ONE PART OF THE COMPUTER TO ANOTHER ALONG AN INTERNAL NETWORK OF PATHWAYS CALLED A BUS.

BASIC ELEMENTS OF A COMPUTER



APPLICATION PROGRAM - A PROGRAM RUNNING IN THE COMPUTER THAT PERFORMS USEFUL WORK SUCH AS AN AIRLINE RESERVATION PROGRAM, A SPREADSHEET PROGRAM OR A WORD PROCESSING PROGRAM. MULTITASKING OR MULTIPROGRAMMING SYSTEMS CAN SUPPORT SEVERAL OF THESE RUNNING A THE SAME TIME.

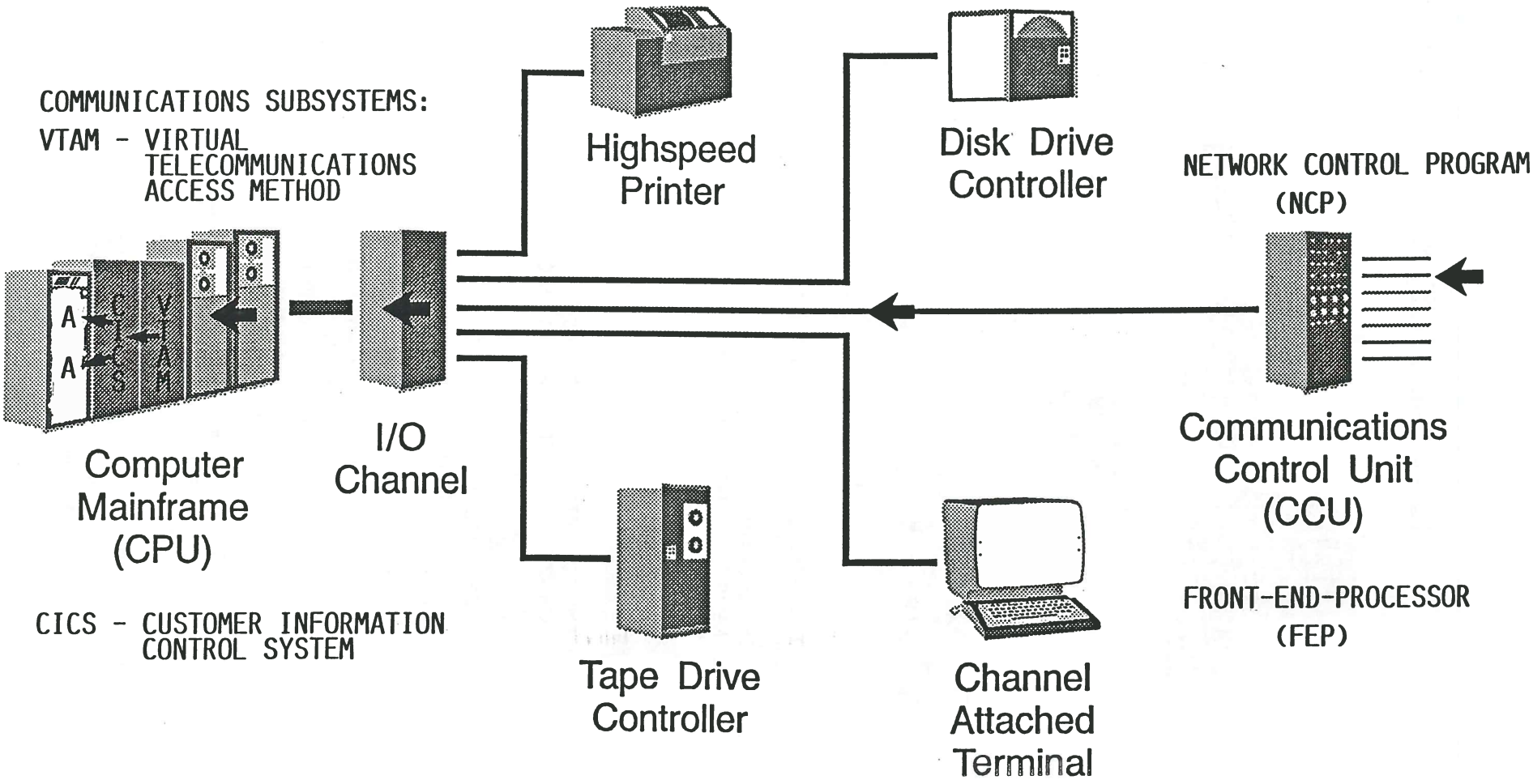
COMMUNICATIONS SUBSYSTEM - THIS IS ANOTHER TYPE OF APPLICATION PROGRAM BUT ONE SPECIFIC TO THE FUNCTION OF PROVIDING DATA COMMUNICATIONS SUPPORT FUNCTIONS FOR THE APPLICATIONS. IN IBM MAINFRAMES THIS WOULD INCLUDE PROGRAMS SUCH AS VTAM, CICS, AND IMS. PROGRAMS SUCH AS PROCOMM, CROSSTALK, SMARTCOM II, ETC. FALL INTO THIS CATEGORY FOR STANDALONE MICROCOMPUTERS. PC LAN PROGRAMS SUCH AS NOVELL'S NETWARE, BANYAN'S VINES, AND 3COM'S 3+OPEN WOULD FIT HERE.

O/S OPERATING SYSTEM - IS ANOTHER PROGRAM BUT THIS ONE RUNS THE BOX. INCLUDED IN THIS CATEGORY IS MVS OR VM FOR IBM MAINFRAMES, UNIX AND VMS FOR MINICOMPUTERS, AND DOS AND OS 2 FOR MICROCOMPUTERS.

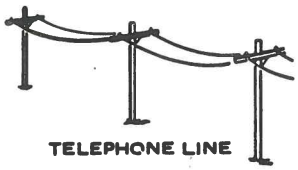
BUS - THE INTERNAL BUS IS AN IMPORTANT ELEMENT IN ANY COMPUTER AS IT IS THE MEANS OF CONNECTING ALL COMPONENTS TOGETHER IN THE COMPUTER. IT IS MADE OF THREE SEPARATE BUS PATHS EACH CONSISTING OF MULTIPLE PARALLEL CHANNELS WHICH CARRY INFORMATION. THE CHANNELS MAY BE 8-BIT, 16-BIT, 20-BIT, 24-BIT, OR 32-BITS.

Data Center Equipment

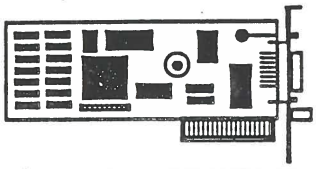
TYPICAL IBM SHOP



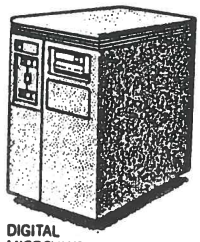
PC COMMUNICATIONS REQUIRED COMPONENTS



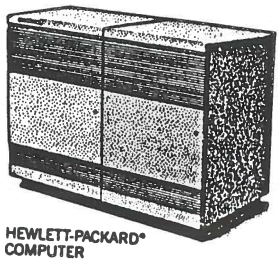
1. MODEM:
   - INTERNAL
   - EXTERNAL
   - "SMART"



COM:1
COM:2

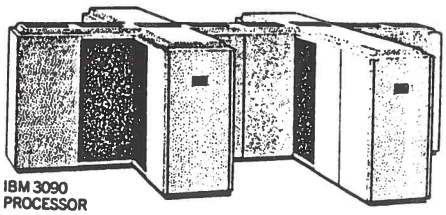


2. COMMUNICATIONS ADAPTER CARD:
   - ASYNCHRONOUS
   - SYNCHRONOUS
   - COMPATIBLE WITH MODEM



3. COMMUNICATIONS SOFTWARE:
   - A. GENERAL ASYNCHRONOUS PACKAGES
     - "CROSSTALK"
     - "PROCOMM"
     - "SMARTERM"
     - "RELAY GOLD"
     - "ETC"

     PROVIDE:
     - ° TERMINAL EMULATION
     - ° FILE TRANSFER
     - ° EASE-OF-USE FEATURES
     - ° COMMAND SCRIPTING, LIKE .BAT FILES



   - B. SPECIALTY SYNCHRONOUS SOFTWARE
     - "3270" COMPATIBILITY
     - UNIQUE MINI/MAINFRAME LINKAGE
   - C. CUSTOM SOFTWARE TO PERFORM A SPECIFIC FUNCTION USING EITHER ASYNC OR SYNC BOARDS

TERMINAL CHARACTERISTICS

TERMINAL COMMAND CODE EXAMPLE

FUNCTION	HAZELTINE EX80	IBM 3101	TELEVIDEO 950
Cursor up	ESC,FF	ESC,A	VT
Cursor down	ESC,VT	ESC,B	LF
Cursor right	DLE	ESC,C	FF
Cursor left	BS	ESC,D	BS
Cursor home	ESC,DC2	ESC,H	RS
Erase screen	ESC,FS	ESC,L	ESC,*
Erase to end of line	ESC,SI	ESC,I	ESC,T
Erase to end of page	ESC,CAN	ESC,J	ESC,Y

COMMUNICATIONS PACKAGES CAN NOT MAP THE PC KEYS
THE MICROCOMPUTER COMMUNICATIONS SOFTWARE PROGRAM, IN ORDER TO EMULATE DIFFERENT TERMINALS MUST CONVERT THE COMMAND CODES THAT ARE RECOGNIZED BY THE TERMINAL TO COMMAND CODES RECOGNIZED BY THE MICROCOMPUTER.

3270 TERMINAL FIELD CHARACTERISTICS

FIELD CHARACTERISTIC	RESULT
Highlighted	Field displayed as a brighterintensity.
Nondisplay	Field does not display any data typed into it.
Protected	Field does not accept any input.
Numeric only	Field accepts numbers only.
Autoskip	Field sends the cursor to the next unprotected field after it is filled with data.
Underscoring	Causes characters to be underlined.
Blinking	Causes characters in the field to blink.

COMMON 3270 KEYS DIFFERING FROM AN IBM PC KEYBOARD

KEY	FUNCTION
CLEAR	ERASES SCREEN EXCEPT FOR CHARACTERS IN MESSAGE AREA REPOSITIONING CURSOR TO ROW1, COLUMN.
PA1/PA2	TRANSMITS SPECIAL CODES TO THE APPLICATION PROGRAM.
PFnn	TWENTY FOUR PROGRAM FUNCTION KEYS WHICH ARE DEFINED BY THE APPLICATION PROGRAM.
TAB	MOVES THE CURSOR TO THE NEXT UNPROTECTED FIELD.
BACKTAB	MOVES THE CURSOR BACK TO THE PREVIOUS FIELD.
NEWLINE	ADVANCES THE CURSOR TO THE FIRST UNPROTECTED FIELD ON THE NEXT LINE.
FASTRIGHT	MOVES THE CURSOR TO THE RIGHT TWO CHARACTERS AT TIME.
ERASE INPUT	CLEARS ALL THE INPUT FIELDS ON THE SCREEN.
HOME	MOVES THE CURSOR TO THE FIRST UNPROTECTED FIELD ON THE SCREEN.

EXAMPLE: "SOFTERM" PC TERMINAL EMULATIONS

TERMINALS EMULATED

TTY COMPATIBLE	HEWLETT PACKARD 2622A
ADDS Regent 20	Honeywell VIP 7205
ADDS regent 25	Honeywell VIP 7801
ADDS Regent 40	Honeywell VIP 7803
ADDS Regent 60	IBM 3101 Model 10
ADDS Viewpoint	IBM 3101 Model 20
Data General D200	Lear Siegler ADM 3A
Datapoint 3601	Lear Siegler ADM 5
DEC VT 52	Televideo 910
DEC VT 102	Televideo 925
Hazeltine 1400/1410	Televideo 950
Hazeltine 1500	User Defined

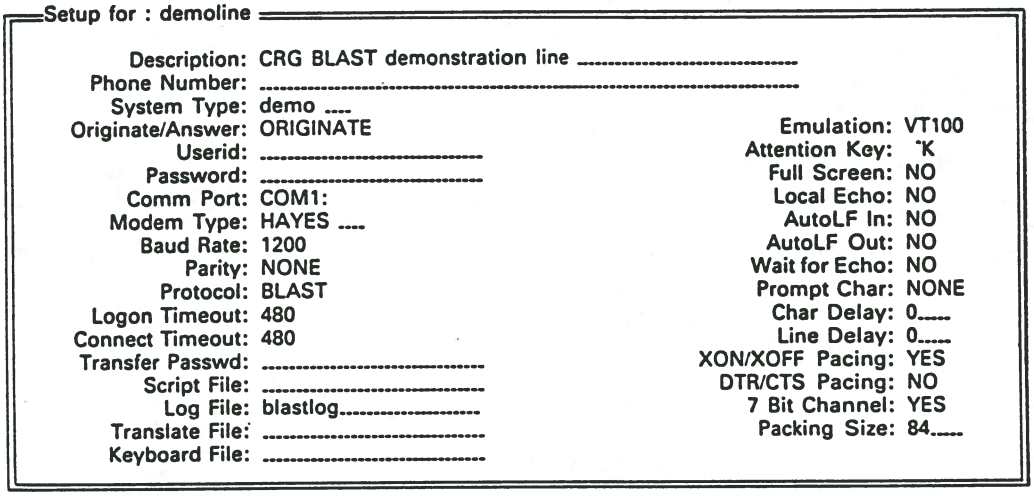
SOFTERM USER DEFINABLE TERMINAL FUNCTIONS

Answerback		
Home Cursor		
Clear Screen		
Erase to End of Line		
Erase to End of Screen		
Insert Line		
Delete Line		
Printer	On	Off
Inverse Video	On	Off
Low Intensity	On	Off
Underline	On	Off
Blink	On	Off
Cursor Up		
Cursor Down		
Cursor Right		
Cursor Left		

EXAMPLE: PC FILE TRANSFER PROTOCOLS

XMODEM	TELINK
YMODEM	KERMIT
ZMODEM	LAP LINK
MODEM7	(PC-PC LOCAL)
BLAST (PC-MINI-MAINFRAME)	

MICROCOMPUTER COMMUNICATIONS PACKAGE FEATURES



Setup for : demoline

Description:	CRG BLAST demonstration line		
Phone Number:			
System Type:	demo		
Originate/Answer:	ORIGINATE	Emulation:	VT100
Userid:		Attention Key:	^K
Password:		Full Screen:	NO
Comm Port:	COM1:	Local Echo:	NO
Modem Type:	HAYES	AutoLF In:	NO
Baud Rate:	1200	AutoLF Out:	NO
Parity:	NONE	Wait for Echo:	NO
Protocol:	BLAST	Prompt Char:	NONE
Logon Timeout:	480	Char Delay:	0
Connect Timeout:	480	Line Delay:	0
Transfer Passwd:		XON/XOFF Pacing:	YES
Script File:		DTR/CTS Pacing:	NO
Log File:	blastlog	7 Bit Channel:	YES
Translate File:		Packing Size:	84
Keyboard File:			

TERMINAL DEFINITIONS AND OPERATIONS CAN BE DEFINED IN DETAIL AND STORED FOR LATER USE. THIS EASES THE CONNECTION EFFORT AND REDUCES THE COMPLEXITY FOR A NOVICE PC USER.

```
SET @PHONENO="8,555-1212"        # Sets number to dail
SET @ BAUDRATE="2400"            # Sets data rate
WAIT UNTIL 21:00                 # Dial when rates cheaper
START                            # label
CONNECT                          # become a terminal to remote system
  IF OK GOTO FILE                # Connection established
  LET @X=X+1                     # increment count
  IF@X=3 GOTO START              # try again
CURSOR 10,10                     # Position cursor
PUT"3 Attempts failed"           # Display message
DISCONNECT                       # hang up modern
FILE                             # beginning of file transfer
```

SCRIPT FILES CAN BE ESTABLISHED WITH SOME PACKAGES TO MAKE THE CONNECTION/LOG ON PROCESS EASY AND AUTOMATIC. THIS IS ESPECIALLY USEFUL WHEN MANY SYSTEMS MUST BE ACCESSED AND/OR A NOVICE OPERATOR IS REQUIRED TO CONNECT TO A SYSTEM.

PC COMMUNICATIONS PACKAGES

STANDALONE PACKAGES FOR COMMUNICATIONS WITH OTHER COMPUTERS:

BLAST
Communication Research

Noise-resistant file transfers, terminal emulation, PC remote control, scripting, background operation, and full automation. Communicates with many other communications packages.

BLAST Satellite
Communication Research

Slave module for control by BLAST.

BLAST w/Remote Control
Communication Research

Blast with PC to PC remote control added. Allows full control of a remote system.

TransPortal Develop. System
Cone Software

PC-based data exchange tool moves data between PCs and mainframes in batch mode without any additional mainframe software. Transfer Scripts can automate a terminal session. Works with any host application that displays on screen. Data stored in .DBF format. Runtime required to distribute scripts.
Requires IRMA or IBM 3270/5250 terminal emulation board.

TransPortal Runtime
Cone Software

Allows 1 PC to use scripts developed with TransPortal.

XTRA PC
Cone Software

Transfer host data to PC for analysis without requiring mainframe software. Eliminates rekeying. Supports 1-2-3, dBase, and other popular packages. Works with IRMA and IBM 3270/5250 terminal emulation.

VistaCom VII
Control Data

Communications package for async, TCP/IP, or DEC net connections. Tek 4107 emulator, script language, file transfer, diagnostics, national character sets, and support for printers and plotters.

MLINK Runtime
Corporate Microsystem

Async. communications software for cross platform connectivity with: terminal emulation, data compression, and error-free file transfers. Can execute scripts created with MLINK Development System.

ProComm Plus
DataStorm Technologies

Communications package with keyboard remapping, powerful script language, automatic dialing directory, context sensitive help, host mode with electronic mail, more.
Network version available.

Crosstalk Mark 4
DCA/Crosstalk

Advanced communications package. Supports up to 15 sessions in windows, several terminals and protocols. Programming language for applications development.

Crosstalk XVI
DCA/Crosstalk

Menu- or command-driven communication program that links PCs to other PCs, micros, mainframes, or info service. Route incoming data. Displays data sent and received.

Remote2
DCA/Crosstalk

Remote control program for off-site operation of PC's. 2 parts: R2HOST and R2CALL. Operate R2HOST from R2CALL, Crosstalk, terminal, or emulator. Has call-back feature.

pcANYWHERE IV
DMA

Control a host PC. Features bi-directional file transfer in backround/foreground, VT220 emulation, speeds up to 115bps, automatic graphics translation, call logging/session record and playback, voice/data switching. Can be loaded in higher memory. With HOST/REMOTE.
Network version available.

pcANYWHERE IV HOST
DMA

Add additional systems that only need to be hosts.

pcANYWHERE IV REMOTE
DMA

Remote side software only.

Brooklyn Bridge
Fifth Generation

Allows a PC or PS/2 to exchange data with another. Use peripherals of or give commands to the remote computer. Rates up to 10K bps.

File Shuttle
GETC

File transfer between PC parallel ports. Transfer rates up to 2M/minute between AT's, 3M/minute between 386's. Tag files, directories, drives, hidden, modified, or date range. Backup hard disks. Macros for repeated operations. Network compatible. Rocket Socket adapter.

Blue Streak Plus
Lang-Allan

Terminal emulation and communication with interface to assembly, C, Turbo Pascal, Clipper, QuickBASIC. Includes two comm ports, simultaneous keyboard definition, resident mode, modem support, and international character translation.

Blue Str. w/Clipper Interface
Lang-Allan

Blue Streak Plus with a Clipper function interface.

Carbon Copy Plus
Microcom Software

Communications package allows access to remote PCs, supports all popular display adaptors, automatic encryption of data. Emulates VT52, VT100, Televideo 920, and IBM 3101 terminals; XMODEM and Kermit file transfer protocols, Crosstalk XVI compatible script language, scrollable look-back window.

Relay Gold
Microcom Software

Communications package sends and receives files in the background. Supports XMODEM, KERMIT, and RELAY protocols. Emulates popular terminals.

Close-Up Customer
Norton-Lambert

Allows full view and control of any PC running the program. Share screens and keyboards with standalone or network PC. Access to DOS or run any application program, transfer files, enter data. Includes complete terminal communications program, password security, 100% error protection, session record/playback.
Works with Close-Up Support.

Close-up Support
Norton-Lambert

Handles remote and automated communications. Full view, control of remote PCs running Close-Up Customer. Share screens/keyboards with network or standalone PCs. Access to DOS, run application programs, transfer files, enter data, run jobs automatically. Password security, 100% error protection, session record/playback.
Works with Close-Up Customer.

FastLynx
Rupp

File transfer between DOS compatible PCs. Split screen, form, and command modes. Self cloning, serial or parallel ports, 200K bps serial and 700K bps parallel, auto-port/auto-baud, online reference, CRC and checksum error checking, context-sensitive help, more.

Takeover
SoftKlone

Remote control with pull-down menus with keyboard or mouse control. Supports mono, CGA, PS/2 model 30 CGA, EGA, VGA, and Hercules. Passwords, automatic call-back to predefined numbers, session recording, background file transfer with file compression. All functions of Mirror III, includes PRISM comm. programming language.

Mirror III
SoftKlone Distributing

Asynchronous data communications package compatible with Crosstalk XVI. Includes programming language, popular terminal emulations, popular file transfer protocols, background mode, and more.

Rapid Transfer Easy
Intertech Marketing

Menu driven file transfers up to 115KB with proprietary error checking. Run from DOS prompt or batch file. Single screen design eliminates wrong way transfers.

Desk-Link
Traveling Software

Connects two PCs with RJ-11 phone wire at up to 1.15K bps. Includes background diskdrive and printer capabilities and dual print spooling.

LapLink III
Traveling Software

Fast data transfer between PCs. Universal cable supports both serial and parallel ports. Transfer speeds up to 3M per minute. Printer and disk drive sharing.

Co/Session LAN
Triton Technologies

Allows network users to dial into and out of LAN via asynchronous communication server. Supports Interrupt 14 and NASI/NCSI interface. Compatible with most communications servers, including: Novell, Banyan, 3COM, Network Products, J&L Cross, Concept Development, and Gateway.
Requires Co/Session Application or Support on remote PC.

Co/Session
Triton Technologies

Provides dual screen/keyboard capabilities on one PC, session recording and playback, remote network access, unattended remote PC control, password protection, terminal emulation mode, background file transfers, remote printing, and more. Includes host and remote PC programs.

Session/XL
Triton Technologies

Automates PC-to-PC communications. Scripting and scheduling communication language. Host PC requires SESSION/XL. Each remote requires CO/SESSION.

PC COMMUNICATIONS PACKAGES

PACKAGES FOR ENABLING A COMPUTER TO OPERATE AS A TERMINAL OF A DIFFERENT TYPE:

COTERM/220
Coefficient Systems

Emulates VT220/100/101/102/52. Kermit, XMODEM, ASCII, and proprietary protocols. Scrollback buffer, toggle between DOS and screen, soft keys, 132 columns with scrolling, and backround file transfer.

BLAST PC
Communication Research

Noise-resistant file transfers, scripting, PC remote control, background operation. Emulations include DEC VT220/100/52, Sperry SVT 1220, Data General D461/411/410 /200, Televideo TV 920, Ampex D80, ADM 3A, WYSE 50, HP 2392, and IBM 3101 plus keyboard remapping.

EM320
Diversified Computer

Emulates DEC VT320, VT220, VT100. True 132 column display, color support, remappable keyboard, DOS hotkey, modem dialer, XMODEM and KERMIT long packet file transfers. Features DCL-like command language, loadable character sets, scroll memory, VMS-like help, and Novell network support.
Versions for PC/TCP, DecNet, Sun PC/NFS, UB Net1, 3-COM.

EM4010
Diversified Computer

Emulates Tektronix 4010/4014 graphics, Retrographics VT640, and DEC VT320/220/100 text terminals. Features high resolution display (1024x768), mouse support, re-rasterized hardcopy, print queueing, and Novell network support. Includes all EM320 features.
Versions for PC/TCP, DecNet, Sun PC/NFS, Net1, 3-COM.

EM4105
Diversified Computer

Emulates Tektronix 4105 color graphics with some 4017 extensions, 4010/4014, VT640 and DEC VT320/220/100 terminals. Supports 640x480 resolution, displays up to 16 colors. Pan/zoom, mouse support, and high resolution color plotting/printing. Includes all EM320 functions with Novell network support.
Versions for PC/TCP, DecNet, Sun PC/NFS, Net1, 3-COM.

ICE.10
James River Group

Three programs: pop-up WYSE 60/ANSI/VT100 terminal emulator that allows a concurrent DOS application; DOS/UNIX file transfer utility; and Unix shell that emulates DOS command line while still accepting Unix commands. Emulator occupies 40K.

ZSTEM 100
KEA Systems

Emulates DEC VT 100, 102, and 52. Includes double high/double wide characters, smooth scrolling, and VT100 line graphics. ASCII, Kermit, and XMODEM file transfers.

ZSTEM 220
KEA Systems

Adds VT220 support to ZSTEM 100. National/multi- national support, downloadable fonts. Integrated network support.

ZSTEM 240
KEA Systems

Adds VT240/1 support to VT220. Includes VT340 ReGIS, Tektronix, and pixel graphics support.

ZSTEM 4014
KEA Systems

Emulates Tektronix 4010/4014. User selectable zoom and pan. Line style mapping and color index support. TIFF output for desktop publishing.

SmarTerm 240
Persoft

Emulates 16-color ReGis graphics of DEC VT340, VT240, and VT241 graphics terminals; VT220 and VT100 text terminals; and Tektronix 4014 graphics terminal. Includes file transfer, LAT, programmable softkey shortcuts, keyboard remapping, menu-driven interface. Multi-user versions. EGA, CGA, VGA, Hercules, 132 col.
Requires asynch I/O board, cabling, 132 column.

SmarTerm 400
Persoft

Emulates DG's D410, D400, D214, D214, D211, D210, D200, and D100 text terminals. Features include softkey language for automatic log-ons and file transfer, multiple configurations, and host remote control. Supports VGA, EGA, CGA, Hercules, 132 column.
Requires asynch I/O board with cabling.

SmarTerm 4014
Persoft

Emulates Tektronix 4014 graphics terminal, uses scaling, zooming and scrolling to view graphics, picture capture and playback. Also emulates VT52/100/102 and TTY.

VTEK
Scientific Endeavors

VT102/100/52 and Tektronix 4010/4014/4105 emulation designed by and for scientists and engineers. Long-packet Kermit, XMODEM; 20 user-defined keys; supports 27 graphics boards and 26 printers and plotters; converts Tektronix to PIC, GEM, HPGL, PostScript; hot key to DOS.

Reflection 1 Plus
Walker Richer & Quinn

Emulates HP 2392A, 700/92 and DEC VT102 terminals. Adds forms caching capability of the HP 2624B, 2394A and 700/94 terminals, and a typeahead buffer. Includes KERMIT, XMODEM, and proprietary file transfers, runs in background, includes script language, is network compatible, and can backup/restore files to/from host.

Reflection 4
Walker Richer & Quinn

Emulates DEC VT240, VT241, and Tektronix 4014 terminals. Supports VT330 and VT340 graphics for 16 color ReGIS applications. Records sessions, has 8 function keys, transfers files with XMODEM or KERMIT, runs in background, has script language, international features, and keyboard remapping.

Reflection 4 Plus
Walker Richer & Quinn

Adds network compatibility and backup/restoration of files to/from host to capabilities of Reflection 4.

Reflection 7 Plus
Walker Richer & Quinn

Emulates the HP 2627A, 2623A, 2392A, Tektronix 4010, and DEC VT102 terminals. All other features similar to Reflection 1 Plus.

SECTION 2.0

STORAGE OF DATA

DATA REPRESENTATION

DIGITAL MACHINES:

Digital Signal

0 0 1 0 0 1 0 0 0 1 1 1 0 0 1 Bits

8 bits = Octet or Byte

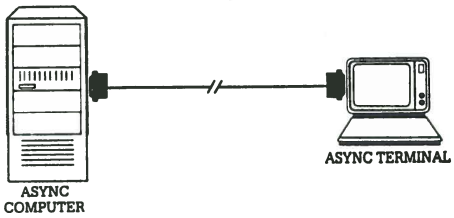
16 bit or 32 bit = Computer Word

TRANSMISSION:

Character = 8 bits of data

or

7 bits of data plus 1 error check bit



Block

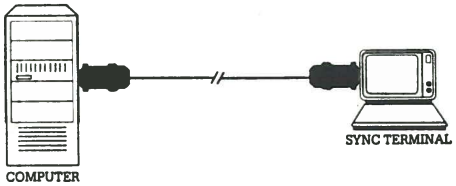
Control characters plus data characters

Transmission Unit = 1 character plus 2-3 timing bits

or

Data Block = 1 to 1000's of characters plus 4 to 100's of control characters

(a.k.a. frame or Packet)



Control Characters = non-data characters that are used to control hardware or transmission functions.

COMMON CODING SCHEMES

ASCII CODE: 7 BITS PER CHARACTER + 1 PARITY BIT OR 8 BITS TOTAL

b7 → b6 → b5 →						0 0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 1
Bits	b4	b3	b2	b1	column → row ↓	0	1	2	3	4	5	6	7
	0	0	0	0	0	NUL	DLE	SP	0	@	P		p
	0	0	0	1	1	SOH	DC1	!	1	A	Q	a	q
	0	0	1	0	2	STX	DC2	"	2	B	R	b	r
	0	0	1	1	3	EXT	DC3	#	3	C	S	c	s
	0	1	0	0	4	EOT	DC4	$	4	D	T	d	t
	0	1	0	1	5	ENQ	NAK	%	5	E	U	e	u
	0	1	1	0	6	ACK	SYN	&	6	F	V	f	v
	0	1	1	1	7	BEL	ETB	/	7	G	W	g	w
	1	0	0	0	8	BS	CAN	(	8	H	X	h	x
	1	0	0	1	9	HT	EM	)	9	I	Y	i	y
	1	0	1	0	10	LF	SUB	*	:	J	Z	j	z
	1	0	1	1	11	VT	ESC	+	;	K	[	k	{
	1	1	0	0	12	FF	FX	,	<	L	/	l	|
	1	1	0	1	13	CR	GS	–	=	M	]	m	}
	1	1	1	0	14	SO	RS	.	>	N	>	n	~
	1	1	1	1	15	SI	US	/	?	O	—	°	DEL

Character Codes

1. Standardized groupings of bits (1's and 0's) to represent alphanumeric and control information.
2. American Standard Code for Information Interchange (ASCII) — ANSI X3.4.
   a. A 7-bit code which yields 128 possible combinations or character assignments.
   b. Ninety-six graphic, i.e., printable or displayable, characters.
   c. Thirty-two control characters, including
      1) Device-control characters such as Line Feed, Carriage Return, Bell, etc.
      2) Information-transfer control characters such as ACK, NAK, etc.

EBCDIC CODE: 8 BITS PER CHARACTER NO PARITY

		00				01				10				11				← Bits 0,1
	Hex1	00	01	10	11	00	01	10	11	00	01	10	11	00	01	10	11	← 2,3
Bits 4567	↓	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	← Hex 0
0000	0	NUL	DLE			SP	&	-									0	
0001	1	SOH	SBA					/		a	j			A	J		1	
0010	2	STX	EUA		SYN					b	k	s		B	K	S	2	
0011	3	ETX	IC							c	i	t		C	L	T	3	
0100	4									d	m	u		D	M	U	4	
0101	5	PT	NL							e	n	v		E	N	V	5	
0110	6			ETB						f	o	q		F	O	W	6	
0111	7			ESC	EOT					g	p	x		G	P	X	7	
1000	8									h	q	y		H	Q	Y	8	
1001	9		EM							i	r	z		I	R	X	9	
1010	A					¢	!	|	:								
1011	B					.	$	.	#									
1100	C		DUP		RA	⟨	.	%	@									
1101	D		SF	ENQ	NAK	(	)	_	·									
1110	E		FM			+	;	⟩	=									
1111	F		ITB		SUB	|	—	?	"								

EBCDIC Code as Implemented for the IBM 3270 Information Display System

Extended Binary Coded Decimal Interchange Code (IBM's EBCDIC).

a. An 8-bit code yielding 256 possible combinations or character assignments.

b. A representative subset, that of the IBM 3270 product family.

Absence of certain functions not usable by 3270 products (e.g., paper feed, vertical tab, back space) which would show up in EBCDIC code charts for other products that might make use of them.

EXTENDED ASCII CODE USAGE

Members of the IBM PC family use a modified ASCII character set which is represented as an 8-bit code. This provides the original 128 characters (2 to the 7th yields 128) in ASCII plus an additional 128 (2 to the 8th yields 256) characters. This is often called extended ASCII.

A problem may occur when transferring PC files since characters in the extended set will be received in error when they are transmitted using 7 data bits. The transmission code version truncates the last bit causing an incorrect character to be sent/received. To prevent this problem from occuring, both the sending and receiving devices must be initialized to the 8-bit ASCII version. This is done but selecting the "NONE" option when defining parity use. In effect, the extra parity bit in ASCII will be used to send more characters and not used for error checking. Error checking must be accomplished in another manner, usually by the block-mode file transfer software protocol being used.

Although conentional ASCII files can be transmitted in 7 bit format, many word processing and computer programs contain text graphics represented by the extended code set. Also, EXE and COM files which are produced by asseblers and compilers contain binary data which must be transmitted in the full 8 bit form. Thes are often called binary files. Some communication programs, while capable of transmitting in 8 bit mode still may not transfer binary files accurately. This is because some communications programs use a special control character, such as the "CONTROL Z" character, to identify the end of a file and may misinterpret a group of 8 bits in the EXE or COM file being transmitted having the same pattern as "CONTROL Z". The result is a premature closing of the file. Special block oriented file transfer programs should be used to avoid this problem.

When communications is performed between two devices that use different coding schemes some sort of code conversion process must be performed. For example, ASCII to EBCDIC code conversion is implemented when an IBM PC is required to operate as a 3270 terminal. This type of terminal is typically connected to an IBM or compatible mainframe computer. The terminal is being replaced by the IBM PC requiring the PC's ASCII code data to be converted to EBCDIC. There are many ways to perform this function. Emulation boards that are inserted into the PC perform code conversion as well as some other duties. An external device can also be used between the PC and the mainframe, such as a protocol converter. However, there are a few versions of EBCDIC so caution must be taken to avoid using an incompatible set.

MEMORY ORGANIZATION

(DOS)

EXAMPLE: PC WITH 20 ADDRESS BUS SIGNAL LINES HAS 1,048,576 BYTES AVAILABLE (16 X 64K BYTES)

MEMORY ALLOCATION HAS BEEN MAPPED OUT AS FOLLOWS:

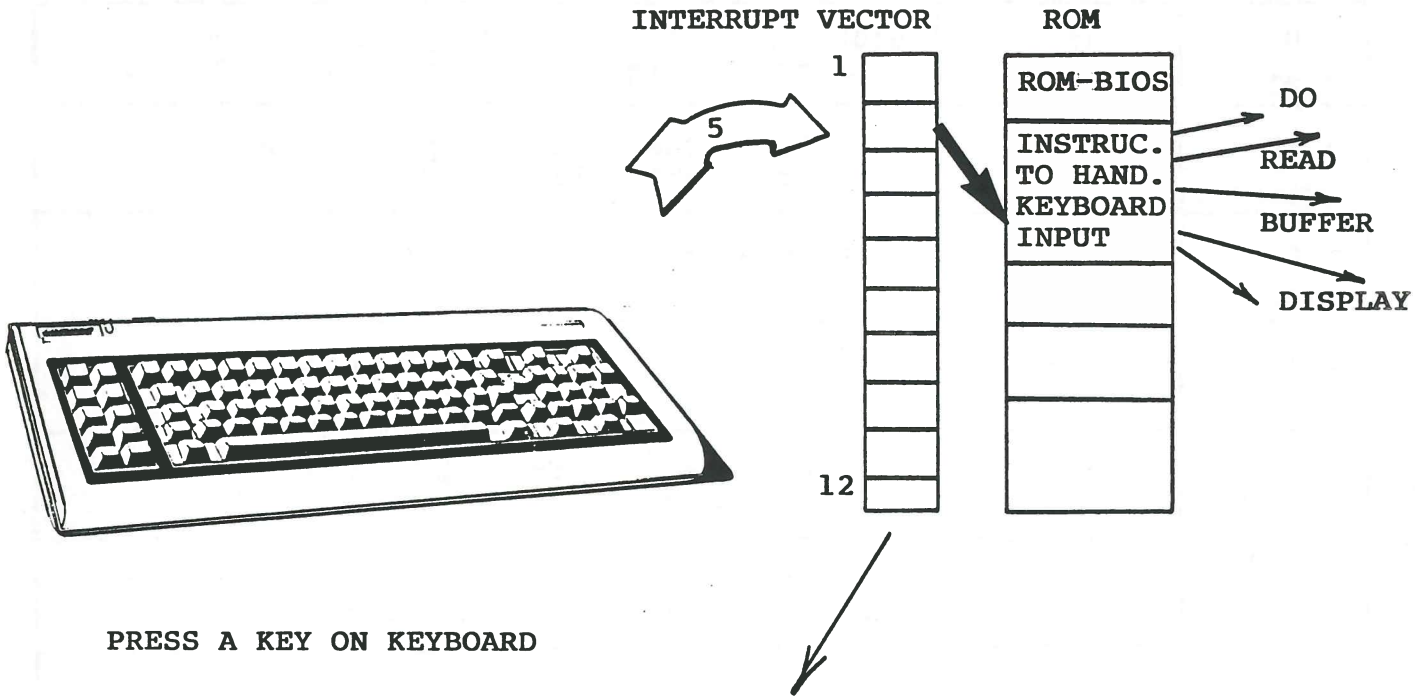
HEX ADDRESS	USAGE
FOOO	PERMANENT ROM: ROM-BIOS, BASIC, DIAGNOSTICS
E000	CARTRIDGE ROM
D000	" "
C000	BIOS EXTENSION - XT DISK
B000	CONVENTIONAL DISPLAY MEMORY
A000	DISPLAY MEMORY EXPANSION - IBM'S EGA
HIGH ORDER	
9000	UP TO 640K
8000	576K
7000	512K
6000	448K
5000	384K
4000	320K
3000	256K
2000	192K
1000	128K
	WORKING RAM - RANDOM ACCESS MEMORY
LOW ORDER	
0000	UP TO 64K GENERALLY USED BY SYSTEM SOFTWARE

ROM - READ ONLY MEMORY - PERMANENTLY RECORDED INFORMATION AND PROGRAMS USED TO RUN THE COMPUTER.

RAM - RANDOM ACCESS MEMORY - USED BY APPLICATION PROGRAMS TO TEMPORARILY HOLD INFORMATION OR PROGRAMS. ALSO, DOS IS LOADED INTO 0-64K

MEMORY MAY BE LOCATED PHYSICALLY ON THE "MOTHER" BOARD OR PARTS OF IT MAY BE ON ADAPTER BOARDS AS ADD-ON MEMORY OR ON COMMUNICATIONS ADAPTER BOARDS AS SHARED BUFFER SPACE.

ROM-BIOS ROUTINES



ALL REQUESTS FOR SERVICE CAUSE AN INTERRUPT WHICH GETS PASSED TO THE CPU FOR PROCESSING. THE CPU WILL INVOKE A HARDWARE HANDLING ROUTINE TO TAKE CARE OF THE REQUEST. IBM'S BASIC INPUT AND OUTPUT SYSTEM (BIOS) IS A SET OF ROUTINES THAT ARE BUILT INTO THE HARDWARE - STORED IN HIGH-ORDER MEMORY OF ROM. THERE ARE 12 BASIC INTERRUPTS WHICH RELATE TO ROM-BIOS.

BASIC INTERRUPTS

1. VIDEO DISPLAY SERVICES
2. DISKETTE SERVICES
3. COMMUNICATIONS
4. CASETTE TAPE
5. STANDARD KEYBOARD SERVICES

   EXAMPLE: - READ NEXT KEYBOARD CHARACTER
   - REPORT IF CHARACTER READY
   - GET SHIFT STATUS

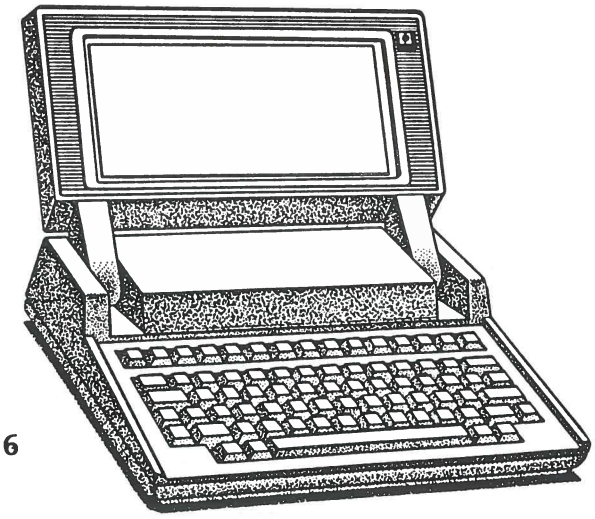
6. PRINTER SERVICES

   EXAMPLE: - SEND ONE BYTE TO PRINTER
   - INITIALIZE PRINTER
   - GET PRINTER STATUS

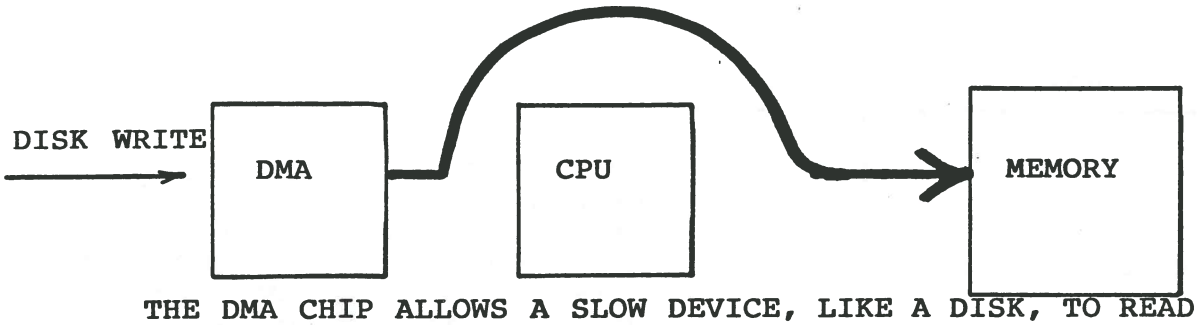
7. EQUIPMENT LIST
8. MEMORY SIZE
9. TIME AND DATE
10. PRINT SCREEN
11. ACTIVATE ROM-BASIC LANGUAGE
12. ACTIVATE BOOT-STRAP START-UP ROUTINE

DOS VERSIONS

VERSION	MODEL	FEATURES
1.0 8/81	PC	640k RAM, 160k 5.25" Floppy, Monochrome Monitor, Single Drive, Single Sided Disks.
1.10 5/82	PC	360k 5.25" Dual drive Floppy, Color Monitor, Double Sided Disks
2.0 3/83	XT	10 M byte Hard Disk, Hiearchical File Structures.
2.1 10/83	PC-Jr Portable	Different BIOS, Half Height Drive
3.0 8/84	PC-AT	32 M bbyte Hard Disk, 1.2 M byte 5.25" Floppy, EGA Monitor
3.1		PC Network, NetBIOS support, File Sharing, Record Locking, different file format.
3.2	Lap Top	720k 3.5" Floppy
3.3 4/87	PS/2	1.44 M byte 3.5" Floppy, MCGA and VGA Monitor, entry level PS/2, improved disk management features, special PS/2 program utilities allow using memory above 1 M byte.
4.0		DOS Shell for Presentation Manager in SAA environment,supports Bank Switching as defined by Expanded Memory Specification (EMS) 4.0 for getting around 640k byte memory limit of DOS, fixed disks greater than 32 M byte supported.

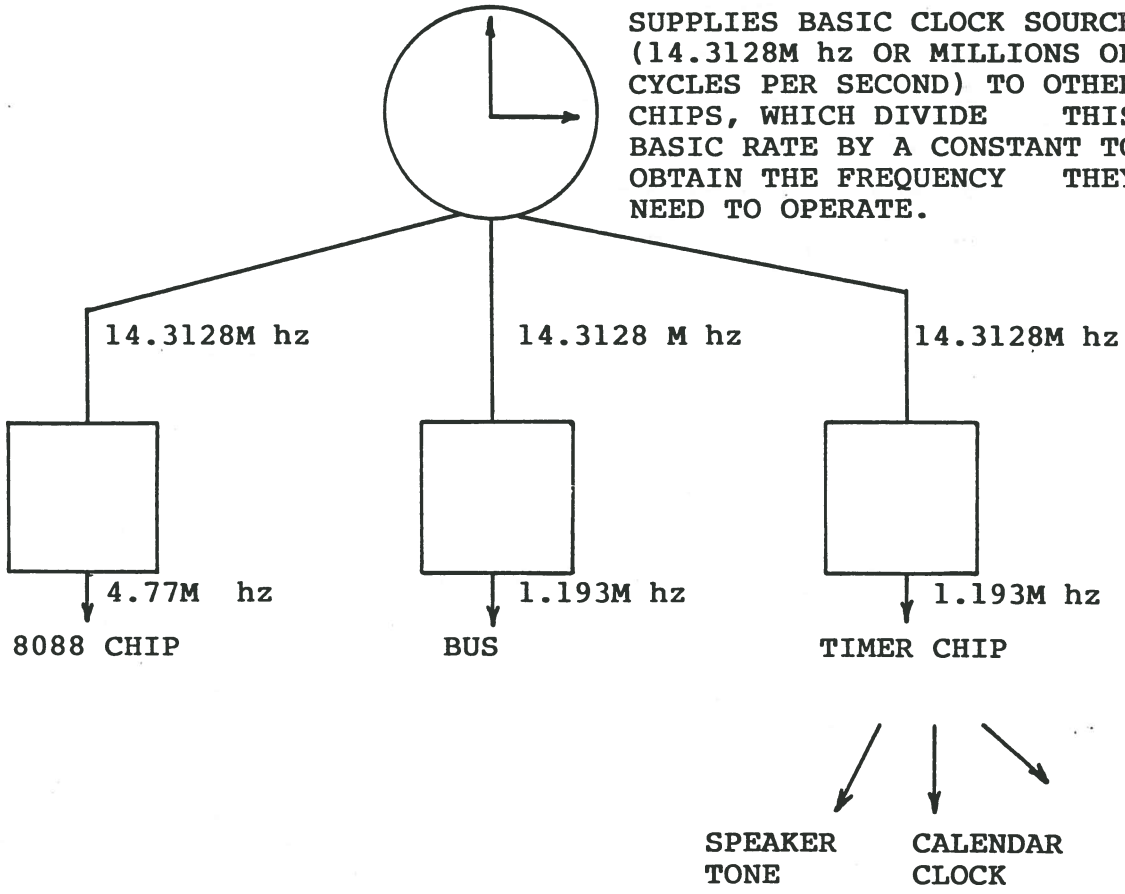


DIRECT MEMORY ADDRESS CHIP

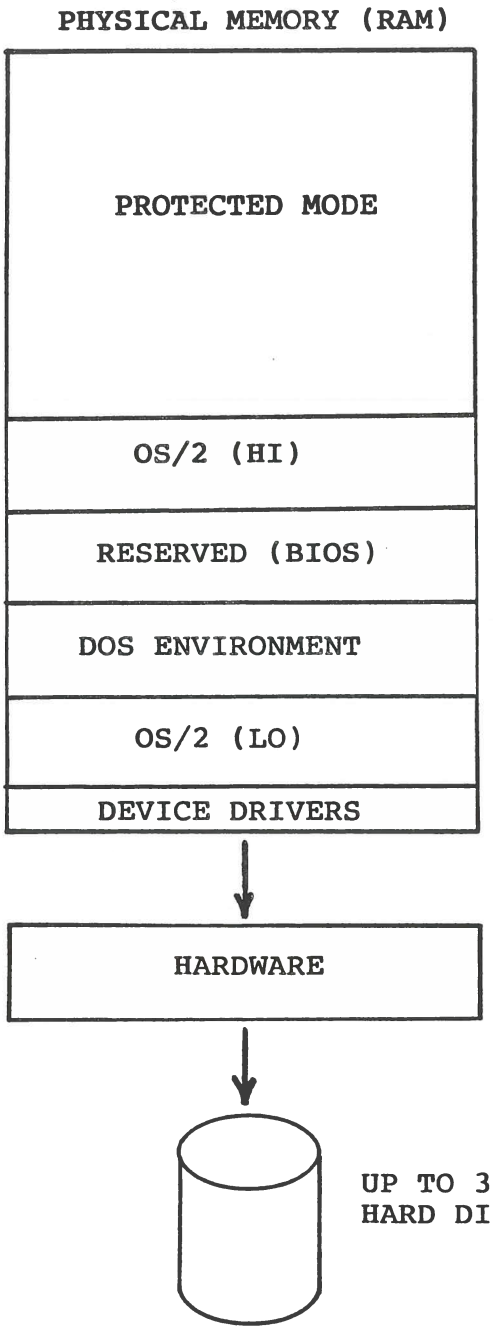


THE DMA CHIP ALLOWS A SLOW DEVICE, LIKE A DISK, TO READ OR WRITE TO MEMORY DIRECTLY WITHOUT TYING UP THE CPU: THIS INCREASES THE OVERALL SYSTEM SPEED. PC AT USES TWO DMA CHIPS.

CLOCK GENERATOR



IBM'S OS/2 PC OPERATING SYSTEM

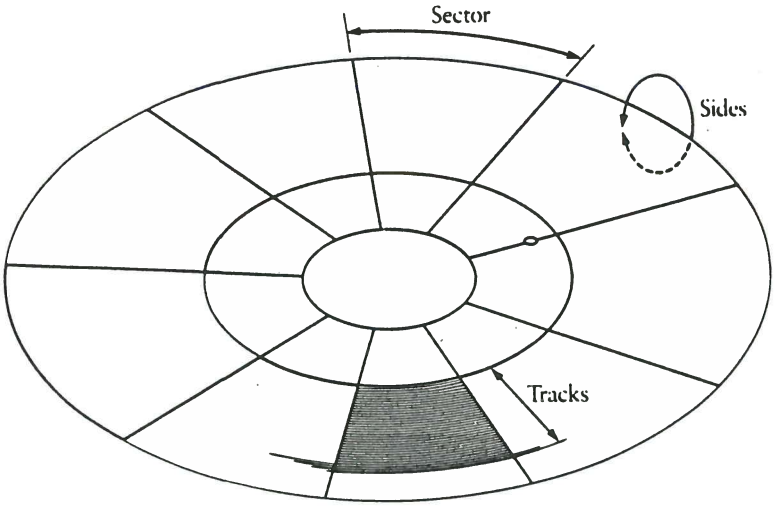


PROTECTED MODE - NO DIRECT CONTROL OF THIS AREA OF MEMORY BY PROGRAMS OTHER THAN OS/2. VIRTUAL MEMORY - PROGRAMS THINK THEY CONTROL THE SPACE, THEY ACTUALLY READ AND WRITE THROUGH OS/2 WHICH TRANSLATES THE ADDRESS SPACE. THIS ALLOWS MULTIPLE PROGRAMS TO RUN USING THE SAME MEMORY AND NOT OVERLAP IN THE SAME ADDRESS OF MEMORY. OS/2 ALSO CAN USE THE HARD DISK SPACE AS TEMPORARY MEMORY TOO. LEAST USED CODE IS SWAPPED OUT BY OS/2 TO THE HARD DISK WHICH YIELDS AN ADDITIONAL 32 M BYTES OF VIRTUAL MEMORY TO 48 M BYTES.

VIRTUAL DEVICES - APPLICATIONS CAN NOT GRAB PHYSICAL DEVICES. OS/2 SHOWS THE APPLICATION WHAT LOOKS LIKE A REAL DEVICE, PRINTER PORT, SCREEN, KEYBOARD, ETC. SO THAT MULTIPLE APPLICATIONS CAN SIMULTANEOUSLY RUN AND SHARE THEM.

MULTITASKING - IS THE ABILITY TO RUN SEVERAL PROGRAMES AT ONCE. OS/2 DOES NOT SUPPORT MULTI-USER OPERATIONS DIRECTLY, BUT CAN THROUGH THE ADDITION OF A NETWORK OPERATING SYSTEM (NOS). HOWEVER, MULTITASKING WILL SUPPORT MULTIPLE SIMULTANEOUS SESSIONS.

PHYSICAL DISK STRUCTURE



TRACKS ARE RECORDING LANES. THE AMOUNT OF DATA STORED ON EACH SIDE OF THE DISK DEPENDS UPON THE NUMBER OF TRACKS, OR DENSITY, AND SIZE OF THE SECTORS

DOUBLE-DENSITY DISKS CAN HAVE 40 TRACKS AND THE NEW QUAD-DENSITY CAN RECORD ON 80.

THE LOCATION OF EACH TRACK AND THE NUMBER OF SIDES PER DISK ARE SET BY THE HARDWARE CHARACTERISTICS OF THE DISK AND DRIVE AND ARE FIXED. HOWEVER, THE LOCATION, SIZE AND NUMBER OF SECTORS WITHIN A TRACK ARE UNDER SOFTWARE CONTROL - THAT'S WHY PC DISKETTES ARE KNOWN AS SOFT-SECTORED.

STANDARD 5¼ DISKETTE

THE CHARACTERISTIC OF THE DISKETTE'S SECTORS - THEIR SIZE AND THE NUMBER PER TRACK - ARE SET WHEN EACH TRACK IS FORMATTED BY THE OPERATING SYSTEM. FOR MOST IBM DOS SYSTEMS, THIS HAS BEEN 512 BYTES PER SECTOR WITH 9 SECTORS PER TRACK.

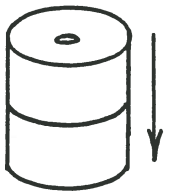
9 SECTORS X 512 BYTES X 40 TRACKS X 2 SIDES = 368,640 BYTES

@ 1024 BYTES PER "K" = 360K BYTES

HARD DISKS

THESE ARE FORMATTED AT THE FACTORY SO THE CAPACITY IS PHYSICALLY FIXED.

A HARD DISK "CYLINDER" IS ONE TRACK DOWN MANY SIDES. HARD DISKS HAVE TWO DISK SURFACES.

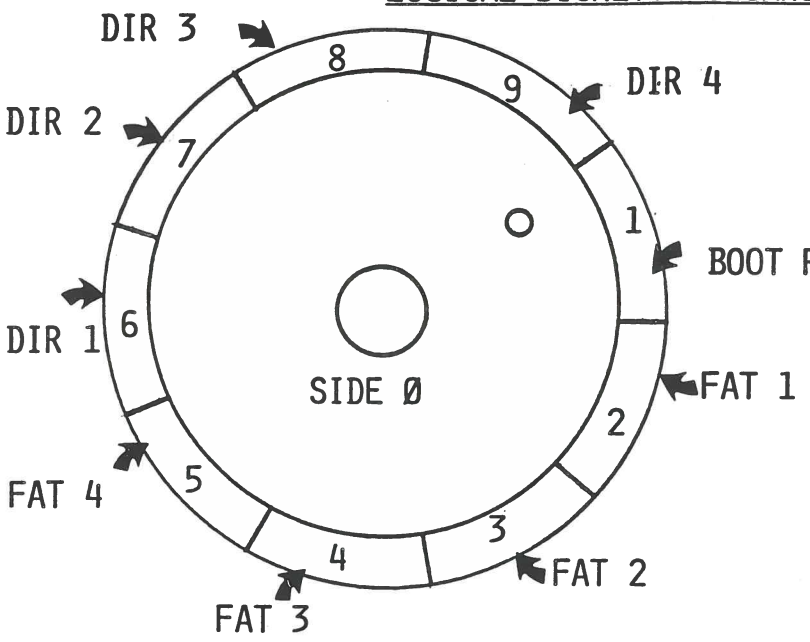


MULTIPLE DISK SURFACES

SIDES	SECTORS	CYLINDERS	NOMINAL SIZE (MEGABYTES)
4	17	306	10
4	17	615	20

A HARD DISK CAN SQUEEZE MORE TRACKS ON THE SURFACE AS IT IS MORE RIGID AND CAN USE DIFFERENT RECORDING METHODS AND MATERIALS.

LOGICAL DISKETTE ORGANIZATION



FILE ALLOCATION TABLE

- SPACE USED
- SPACE AVAILABLE
- BAD SECTORS
- STARTING FILE SECTOR
- FILE ALLOCATION CHAIN

BOOT RECORD — A SINGLE SECTOR LOCATED AT SECTOR 1, TRACK Ø, SIDE Ø WHERE "BOOT LOADER" PROGRAM AND OTHER RECORDS DESCRIBING THE DISK FORMAT ARE LOCATED.

FILE ALLOCATION TABLE — THIS IS THE OFFICIAL RECORD OF THE DISK'S FORMAT AND MAPS OUT THE LOCATION OF THE SECTORS USED BY THE DATA FILES. EACH ENTRY IN THE TABLE CONTAIN A SPECIFIC CODE TO INDICATE WHAT SPACE IS BEING USED, WHAT SPACE IS AVAILABLE, AND WHAT IS BAD. THERE ARE TWO COPIES OF THE FAT BECAUSE IT IS SO IMPORTANT, EACH TAKING 1-2 SECTORS ON THE $5\frac{1}{4}$" FLOPPY AND 41 EACH ON HARD DISKS.

DIRECTORY — THE FAT ALSO HAS THE STARTING SECTOR NUMBER FOR EACH DATA FILE ON THE DISK. BECAUSE THE DISK SPACE IS ALLOCATED ON AN AS NEEDED BASIS, A FILE MAY NOT BE RECORDED ON CONTINUOUS SECTORS. THE FAT CONTAINS A FILE SPACE ALLOCATION CHAIN TO KEEP TRACK OF WHERE THE FILE IS.

THE DIRECTORY IS A TABLE OF CONTENTS AREA:

- FILE NAME
- FILE NAME EXTENSION
- ATTRIBUTE
- TIME CREATED
- DATE CREATED
- STARTING FAT ENTRY
- FILE SIZE

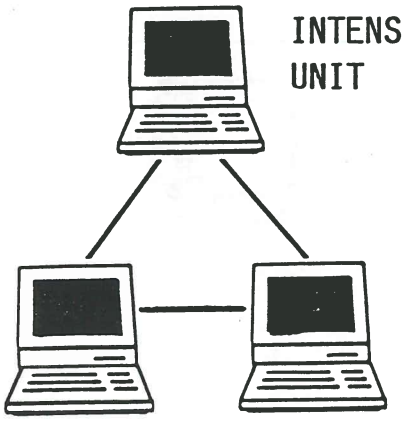
> WHEN A FILE IS ERASED, THE FIRST BYTE OF THE NAME IS SET TO HEX E5 AND THE FAT ALLOCATION SPACE CHAIN IS WIPED OUT BUT THE REST OF THE DIR. IS KEPT ALONG WITH DATA.

SECTION 3.0

TRANSMISSION RULES AND CONTROLS

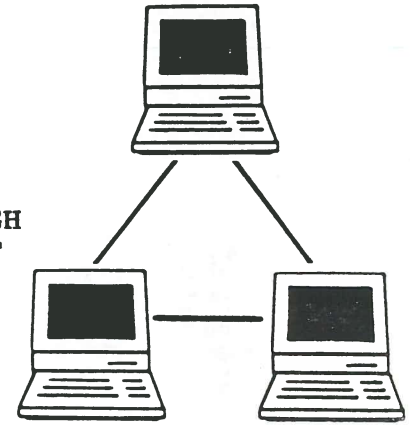
CASE STUDY

HOSPITAL SYSTEMS INTEGRATION



INTENSIVE CARE UNIT

CLINICAL OFFICE



EACH DEPARTMENT NEEDS TO TRACK A PATIENT THROUGH A SYSTEM KEEPING TRACK OF IDENTIFICATION, TREATMENT, RESULTS, ETC. CAN PROVIDE INSTANT INFORMATION ABOUT A PATIENT ANYWHERE IN THE HEALTHCARE SYSTEM LIKE FEDERAL EXPRESS KNOWS WITHIN MINUTES WHERE PACKAGES ARE.

THE MAJOR PURPOSE OF THE NETWORK IS TO ASSIMILATE CLINICAL INFORMATION ON PATIENTS TO USE IN DOCUMENTATION, WORK ASSIGNMENTS, ORDERING, CHARGE CAPTURE, BILLING, AUDITING, RECORD KEEPING, QUALITY ASSURANCE, AND SOME PERSONAL COMMUNICATIONS.

PATIENT RECORDS

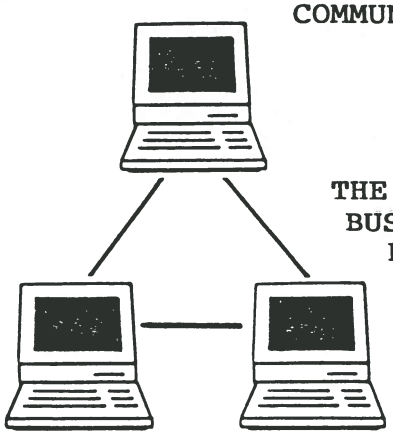
EACH AREA HAS THE POWER, INFORMATION AND TOOLS AT THEIR LOCATION TO DO THE JOB. SOME USE BAR CODE READERS TO COLLECT DATA SUCH AS THE THERAPIST, PATIENT, PROCEDURE AND SUPPLY.

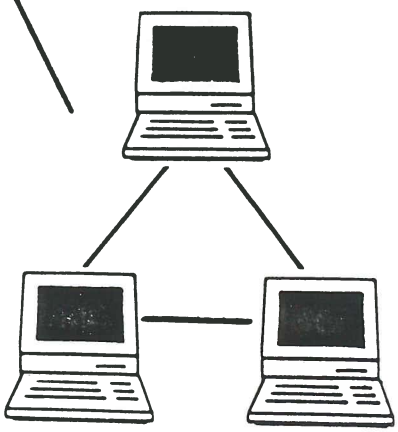
SOME INFORMATION IS KEPT AT THE LOCAL LEVEL AND OTHER DATA IS PASSED TO A CENTRAL REPOSITORY.

PULMONARY DIAGNOSTIC LAB

RESPIRATORY MANAGEMENT OFFICES

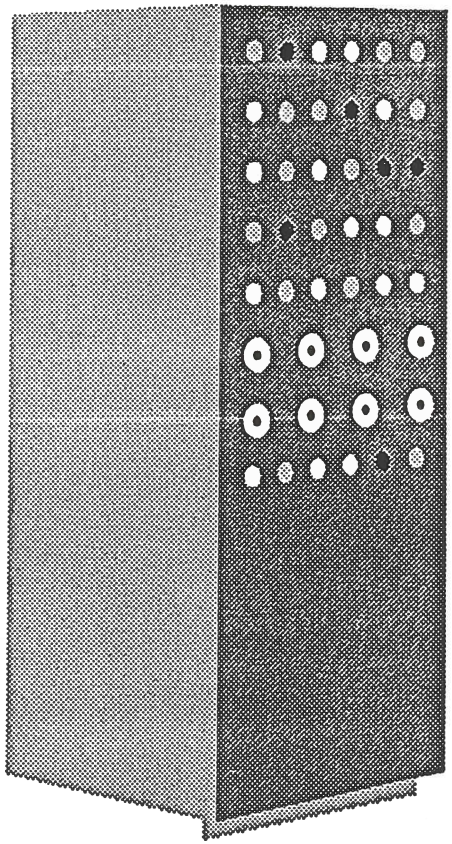
THE NETWORKS WILL ALSO MEET THE STANDARD BUSINESS NEEDS OF THE HOSPITAL, SUCH AS WORD PROCESSING, SPREADSHEETS, ETC. FOR NO ADDITIONAL NETWORK OR COMMUNICATIONS COSTS.





THE NETWORK IS INTERCONNECTED TO BUSINESS MAINFRAME, OTHER BUILDINGS AROUND THE TEACHING HOSPITAL AND DOCTOR'S OFFICES. PRACTICE MANAGEMENT SOFTWARE IS SHARED BY INDIVIDUAL DOCTORS ON THE NETWORK ALSO.

Communication Modes



CCU

SIMPLEX

only

HALF-DUPLEX

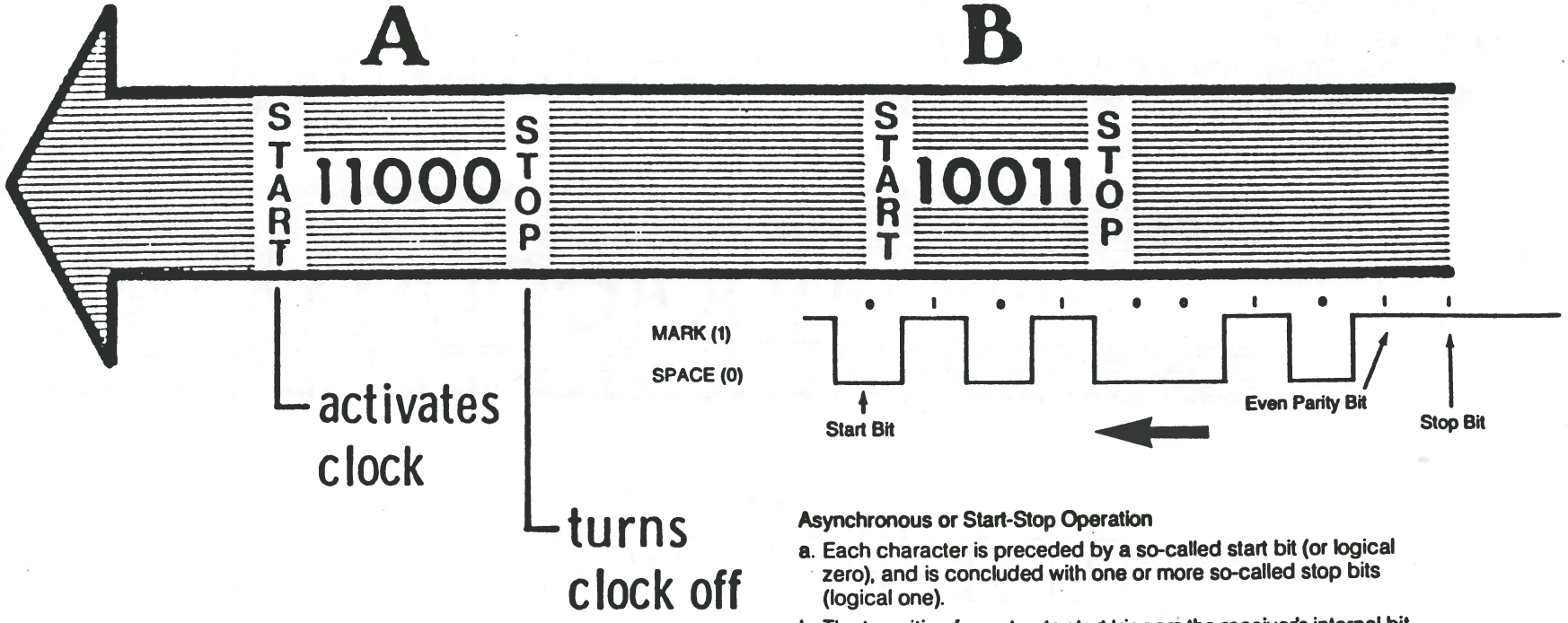
or

FULL-DUPLEX

and

ASYNCHRONOUS TRANSMISSION

The bit pattern for each character is preceded by a START and followed by a STOP bit:



(a.k.a. START/STOP TRANSMISSION)

Asynchronous or Start-Stop Operation

a. Each character is preceded by a so-called start bit (or logical zero), and is concluded with one or more so-called stop bits (logical one).

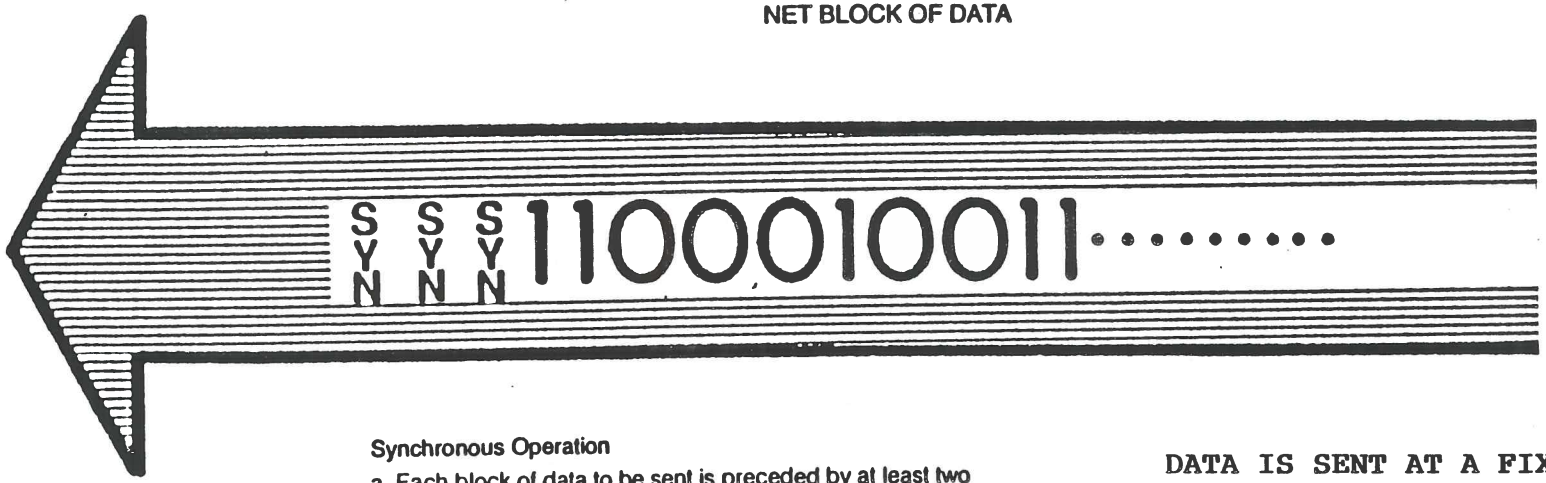
b. The transition from stop to start triggers the receiver's internal bit rate clock. The receiver then accepts (and discards) the start bit, accepts the number of bits appropriate to the code set, and is conditioned by the stop bit for the next character.

c. Zero bits may also be referred to as SPACES, and one bits may also be referred to as MARKS.

d. Start-stop synchronization enables characters to be sent at random, since each character carries the necessary synchronizing information with itself.

SYNCHRONOUS TRANSMISSION

NET BLOCK OF DATA



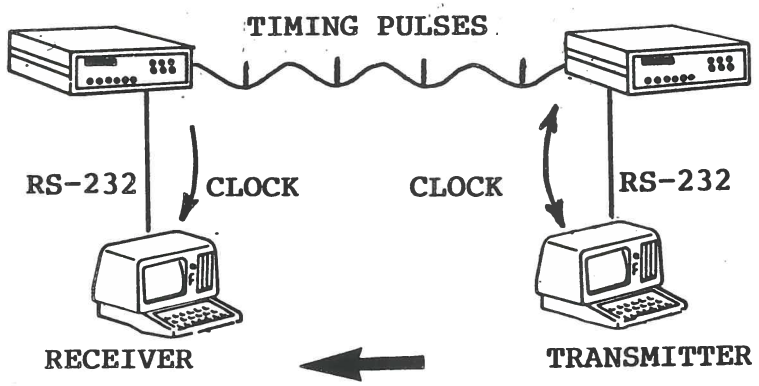
Synchronous Operation

a. Each block of data to be sent is preceded by at least two so-called SYN or synchronizing characters (see ASCII and EBCDIC code charts).

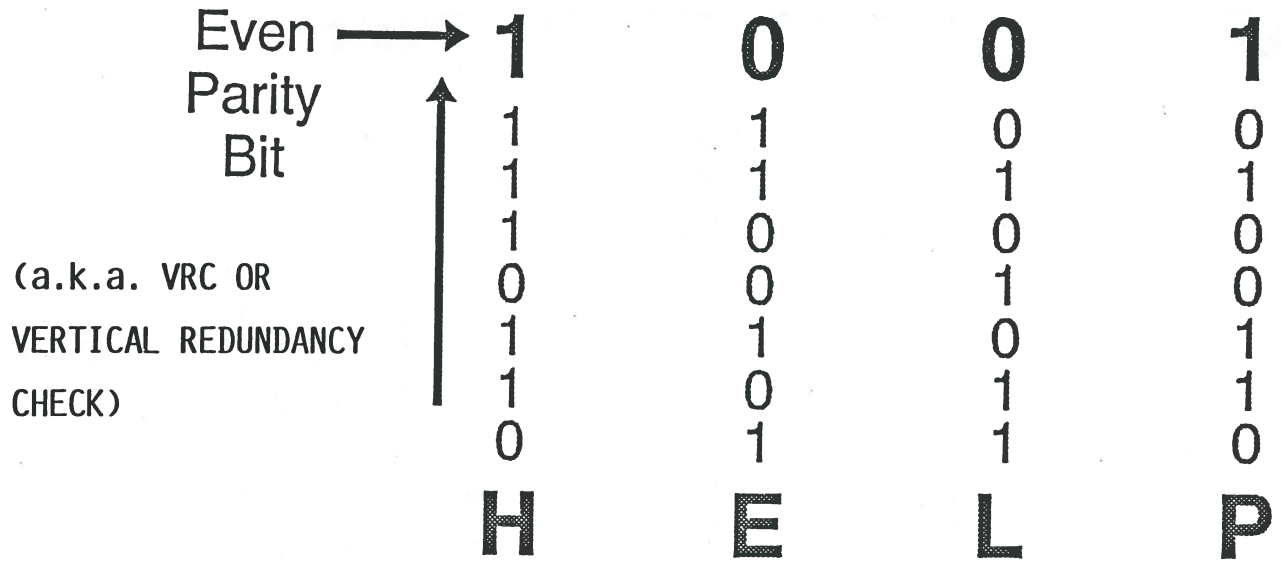
b. A receiver is designed to always look for such SYNs. When it sees at least two in a row, by definition the next group of bits (appropriate to the particular code being used) will be a data character if not another SYN character.

c. Synchronous operation requires that characters be sent without any pause between them (i.e., from a buffer storage of some sort).

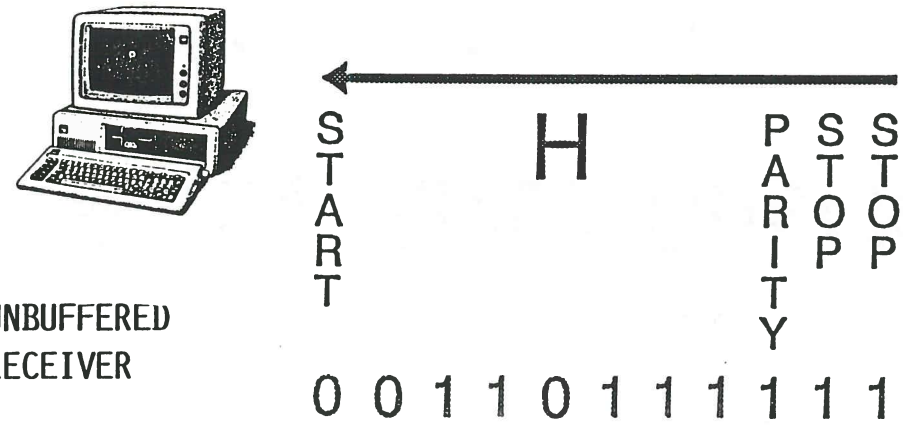
DATA IS SENT AT A FIXED RATE WITH THE TRANSMITTER AND RECEIVER SYNCHRONIZED. THE MODEM PASSES THE CLOCK PULSES TO THE RECEIVE TERMINAL.



Parity Error Checking

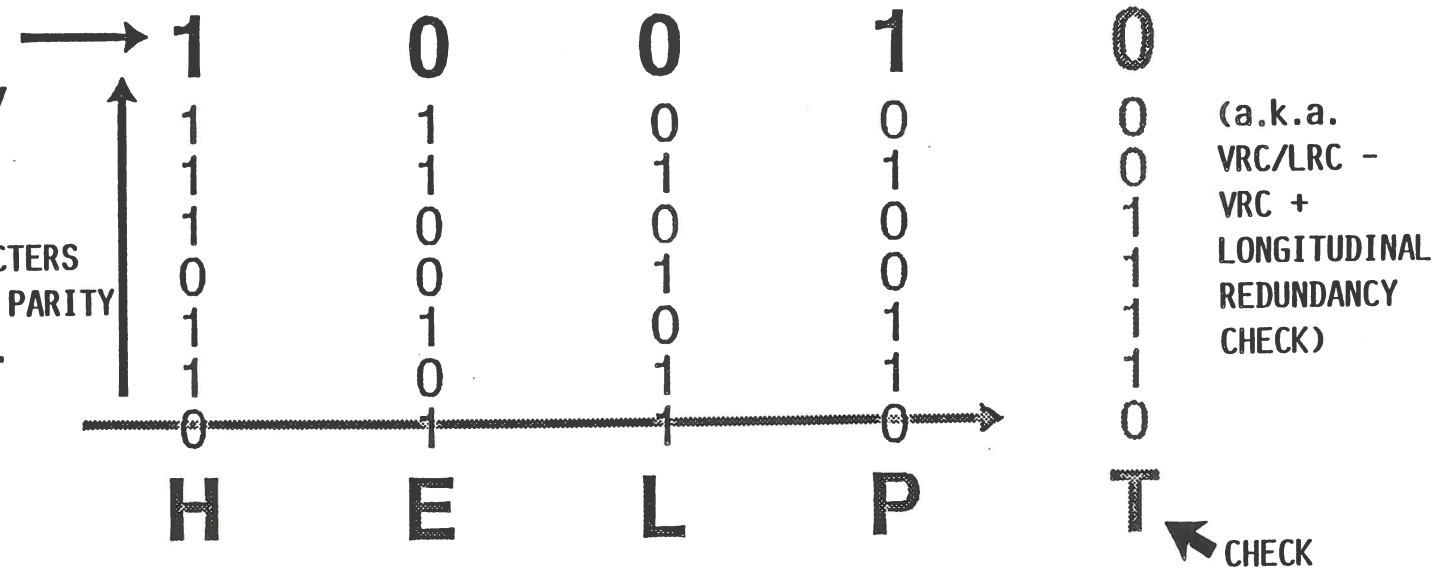


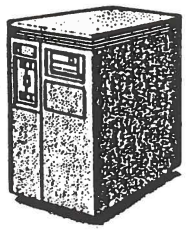
TRANSMITTER ADDS AN EXTRA BIT TO EACH CHARACTER TO MAKE THE ENTIRE BIT STRING AN EVEN (OR ODD) 1's COUNT. RECEIVER MUST CHECK FOR AN EVEN COUNT TO CHECK FOR BIT ERRORS.



THE RECEIVER MAY OR MAY NOT TAKE ACTION IF ERROR OCCURS. THIS DEPENDS ON THE PROTOCOL RULES BEING USED.

Parity Error Checking



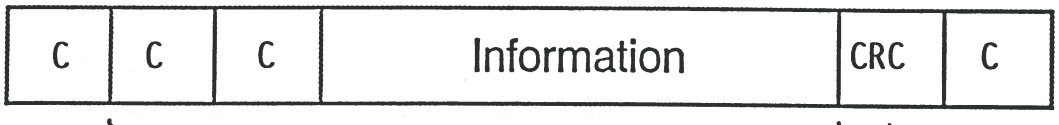


START H PARITY STOP STOP

0 0 1 1 0 1 1 1 1 1 1

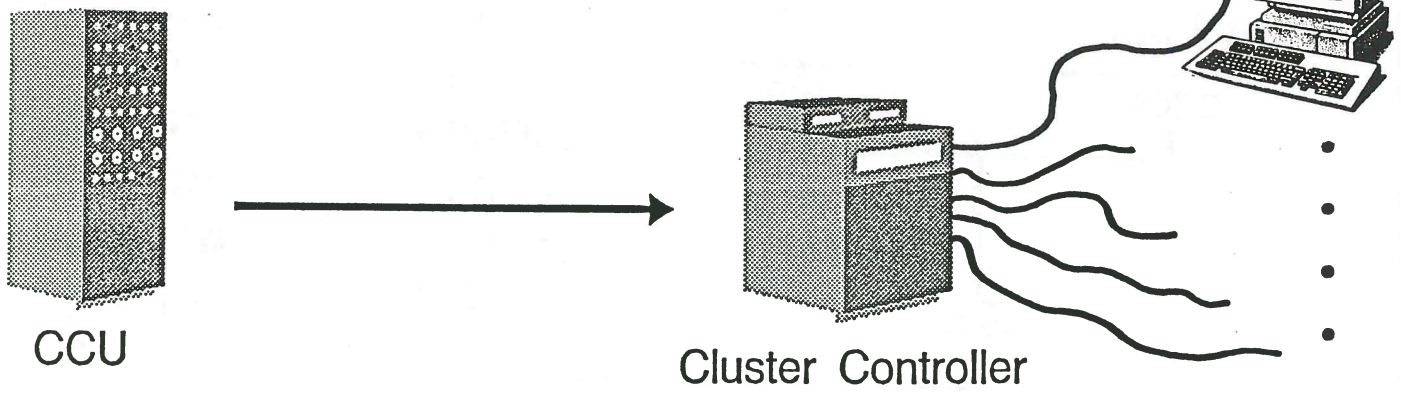
BUFFERED DEVICES HOLD STRINGS OF CHARACTERS ALLOWING FOR A MATRIX PARITY CHECK TO BE PERFORMED. THIS IS MORE ACCURATE THAN VRC AS TWO ERRORS IN ONE CHARACTER STILL CAN BE DETECTED. THE TRANSMITTER CREATES ANOTHER CHARACTER IN THE PROCESS AND ADDS IT TO THE END OF THE TRANSMITTED STRING. THE RECEIVER HOLDS THE ENTIRE STRING IN ITS BUFFER, CHECKS IT, AND COMPARES IT CREATED CHARACTER WITH THE LAST ONE RECEIVED.

Cyclic Redundancy Check (CRC)



$$\frac{10110110111100010111100...}{10101110} = R_1$$

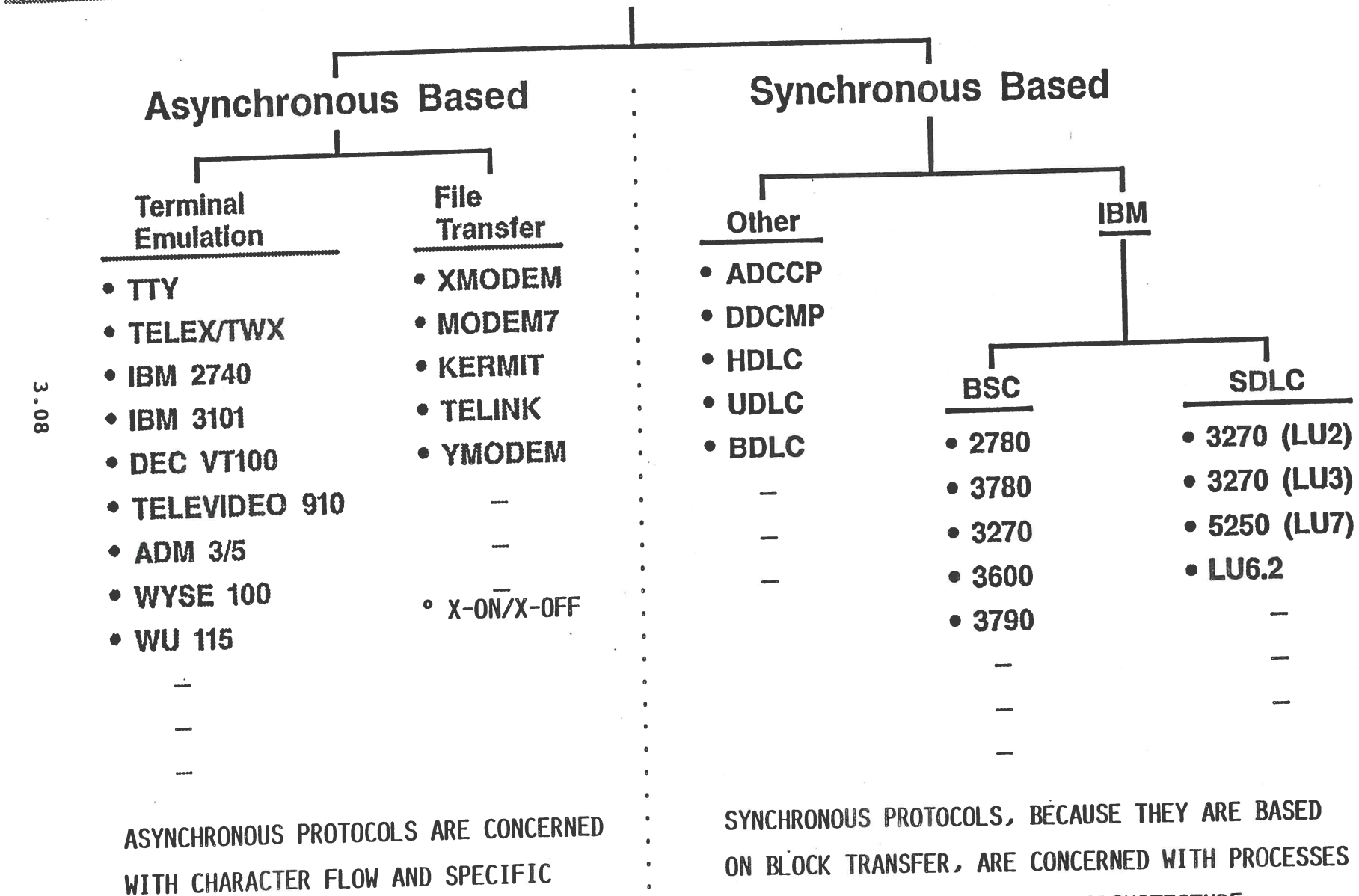
TRANSMITTER PERFORMS A BINARY DIVISION WITH A KNOWN DIVISOR AND PLACES THE REMAINDER IN A 2 CHARACTER FIELD OF A DATA BLOCK.



$$\frac{10110110111100010111100...}{10101110} = R_2$$

THE RECEIVER PERFORMS THE SAME CALCULATION WHEN THE DATA ARRIVES, COMES UP WITH ITS OWN REMAINDER, THEN COMPARES IT WITH THE ONE SENT BY THE TRANSMITTER. IF THEY ARE DIFFERENT, THEN AN ERROR HAS OCCURED. ACTION DEPENDS ON PROTOCOL.

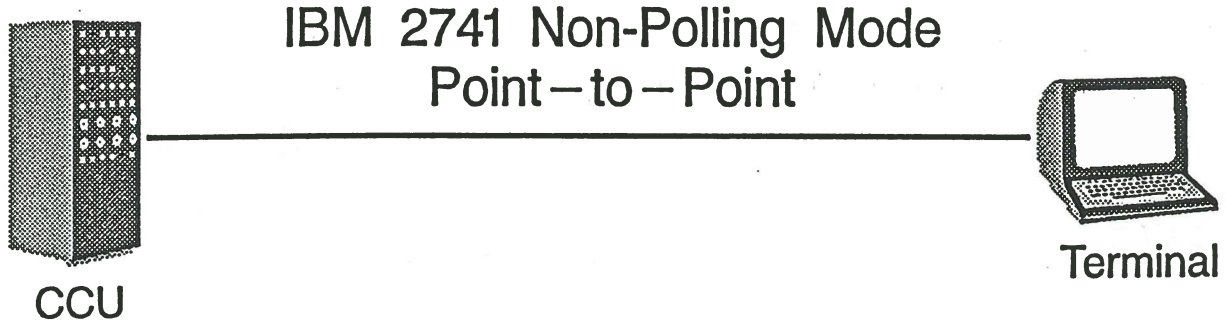
Transmission Protocols

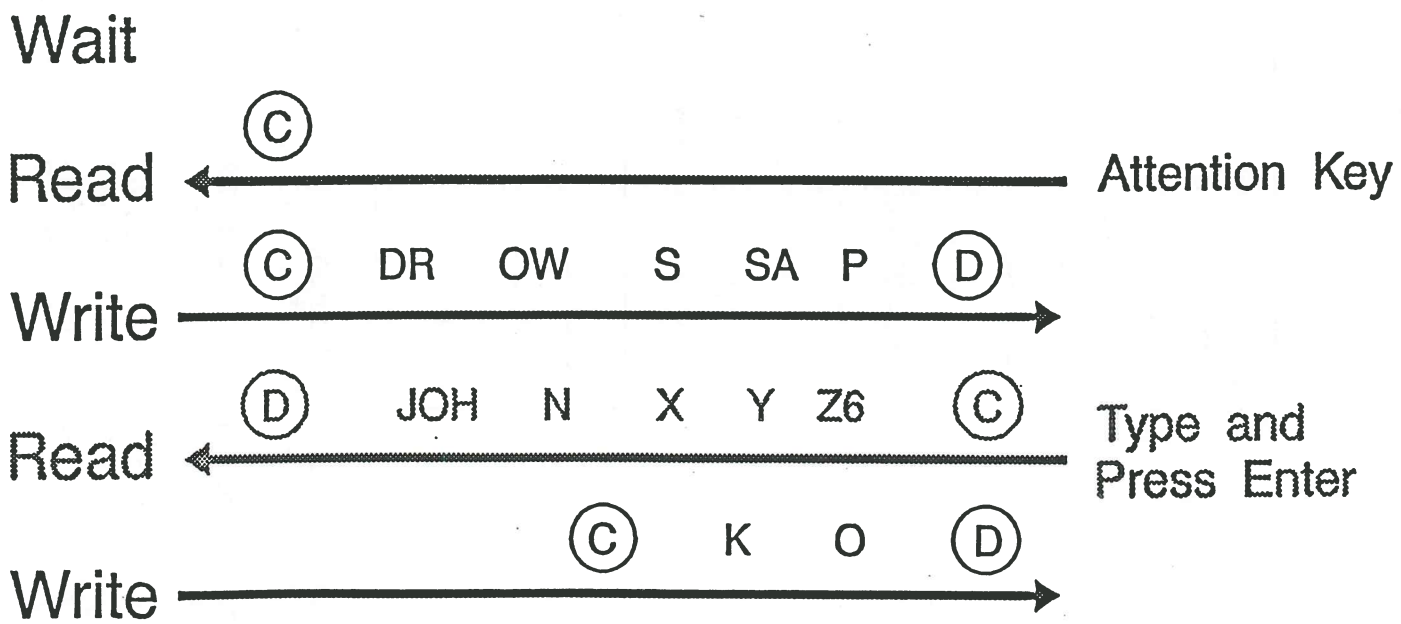


ASYNCHRONOUS PROTOCOLS ARE CONCERNED WITH CHARACTER FLOW AND SPECIFIC TERMINAL FEATURES. FILE TRANSFER TECHNIQUES AUTOMATICALLY CORRECT ERRORS

SYNCHRONOUS PROTOCOLS, BECAUSE THEY ARE BASED ON BLOCK TRANSFER, ARE CONCERNED WITH PROCESSES AND SUPPORT THE HIGH LEVEL ARCHITECTURE REQUIREMENTS... THE DATA LINK CONTROL (DLC) ONES.

Asynchronous Protocol Example

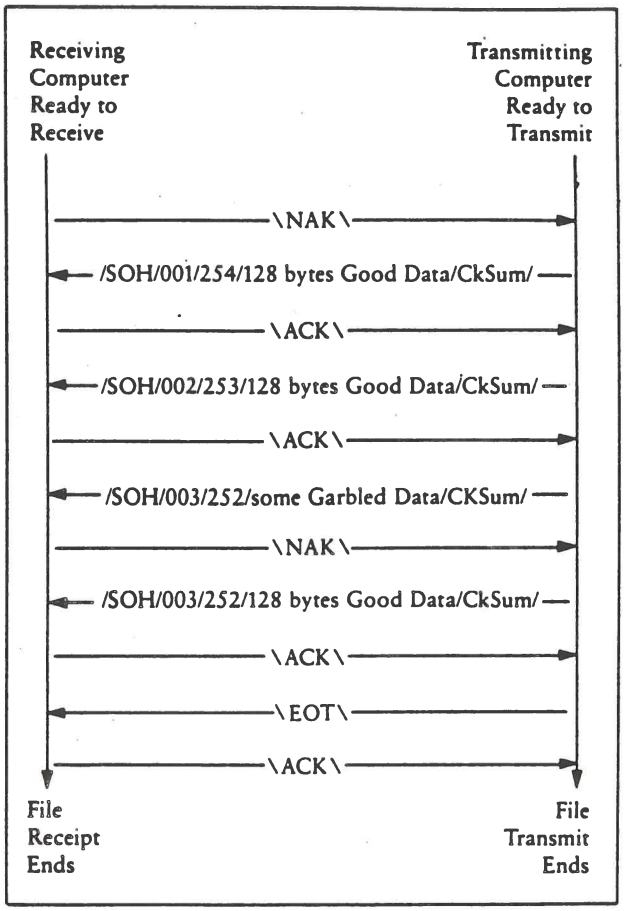




"CONTROL" C AND "CONTROL" D ARE USED AS FLOW CONTROL CHARACTERS AND ARE IN ADDITION TO THE TERMINAL CONTROL CHARACTERS SUCH AS CR (CARRIAGE RETURN) AND LF (LINE FEED), ETC.

XMODEM

FILE TRANSFER PROTOCOL



- WARD CHRISTENSEN XMODEM PROTOCOL IS PUBLIC DOMAIN FILE TRANSFER TECHNIQUE WHICH YIELDS 99.6% TRANSMISSION ACCURACY.

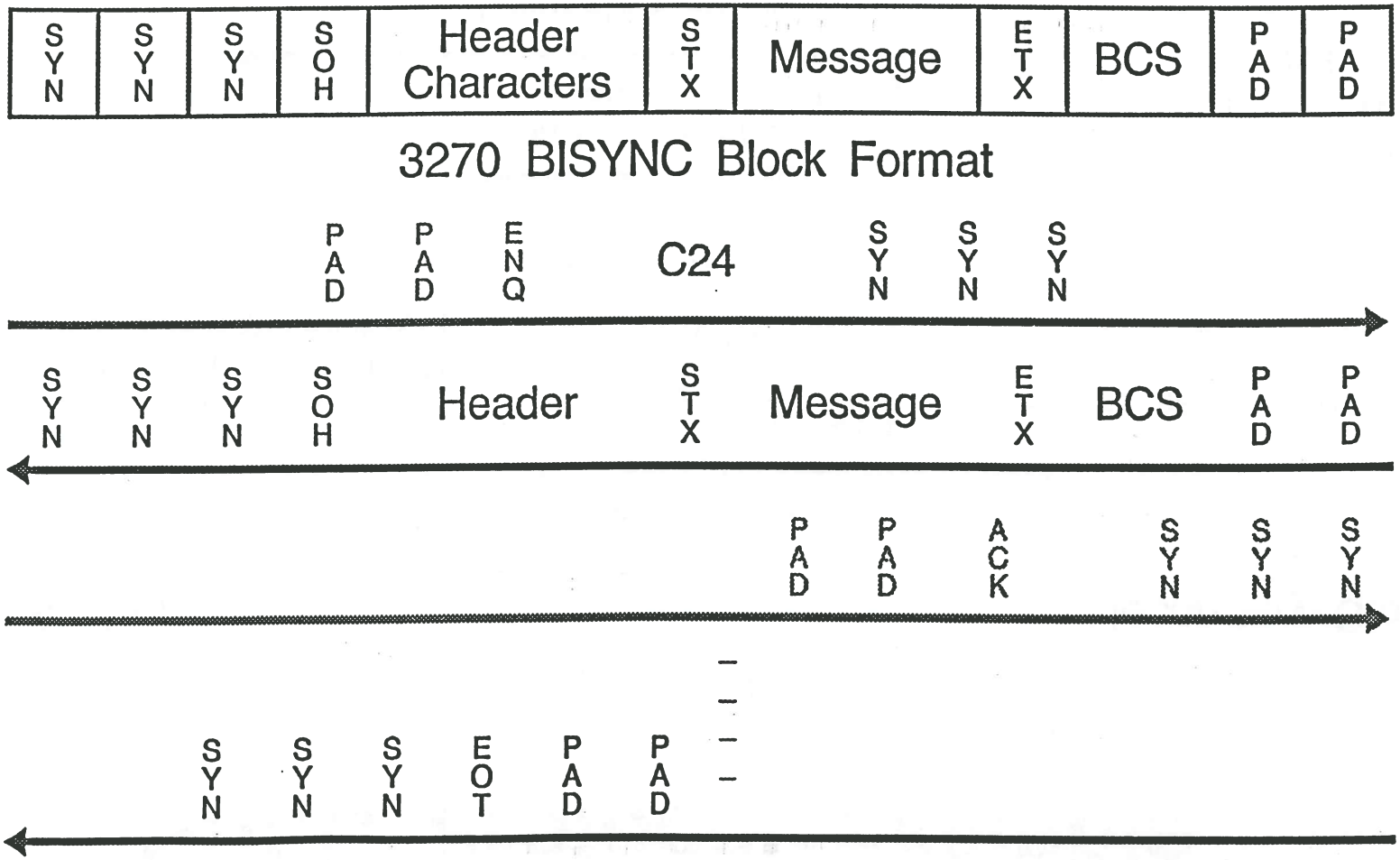
- RECEIVING COMPUTER SIGNALS TRANSMITTING COMPUTER ITS READY BY SENDING THE NEGATIVE ACKNOWLEDGE (NAK) CHARACTER.

- AFTER RECEIVING NAK, XMODEM SENDS A START OF HEADER (SOH) CHARACTER; FOLLOWED BY TWO CHARACTERS WHICH REPRESENT THE BLOCK NUMBER AND ITS ONES COMPLEMENT; FOLLOWED BY A 128 CHARACTER BLOCK OF DATA; FOLLOWED BY AN ERROR CHECKING CHECKSUM.

- IF THE BLOCK IS RECEIVED CORRECTLY THE RECEIVING COMPUTER RETURNS A POSITIVE ACKNOWLEDGE CHARACTER TO TELL THE TRANSMITTER TO SEND THE NEXT SEQUENTIAL BLOCK; WHEN ALL BLOCKS ARE RECEIVED THE TRANSMITTER SENDS AN END-OF-TRANSMISSION CHARACTER (EOT).

- IF A BLOCK IS RECEIVED IN ERROR THE RECEIVING COMPUTER RESPONDS WITH A NAK AND THE TRANSMITTER COMPUTER RETRANSMITS THE BLOCK AGAIN UNTIL IT'S RECEIVED CORRECTLY.

BInary SYNChronous Communications Protocol



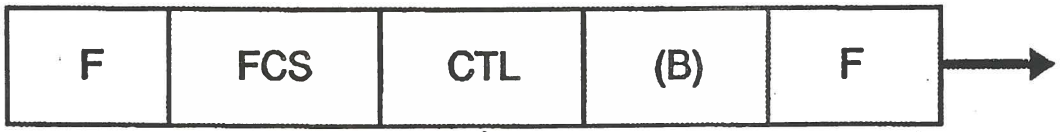
AN EARLY, BYTE ORIENTED PROTOCOL THAT USES DEFINED FIELDS TO CARRY FORMAT IDENTIFIERS AND LOW LEVEL CONTROL INFORMATION SUCH AS TERMINAL ADDRESS AND BLOCK LEVEL ERROR CHECKING. THIS HALF DUPLEX PROTOCOL DOES NOT SUPPORT ADVANCED ARCHITECTURES.

SDLC Protocol Example

(Half-Duplex)

Primary Station (A)

Secondary Station (B)



Supervisory
CC=RR
Nr=O P/F=1

MANY ADDITIONAL CONTROL FIELDS TO INCREASE TRANSMISSION EFFICIENCY AND TO PROVIDE MORE APPLICATION SUPPORT FEATURES

POLL REMOTE DEVICE FOR DATA.

Information Format
Nr=O Ns= P/F=O

Information Format
Nr=O Ns=2 P/F=O

Information Format
Nr=O Ns=3 P/F=1

Supervisory or Information Format
Nr=3 Ns=O

DEVICE CAN SEND UP TO 7 FRAMES AT ONCE.

RECEIVER ACKNOWLEDGES 3 FRAMES RECEIVED SUCCESSFULLY

STANDARDS GROUPS

AMERICAN NATIONAL STANDARDS

American National Standards
Institute
1430 Boradway
New York, NY 10018
212-642-4900

CCITT RECOMMENDATIONS

United States Department
of Commerce
National Technical
Information Service (FIPS)
5285 Port Royal Rd.
Springfield, VA 22161
703-487-4600

International Telegraph
and telephone Consultative
Committee (CCITT)
Place des Nations
CH-1211 Geneva 20,
Switzerland
41 22 99 51 11 (tel.)

CCITT standards books can
be obtained from:
Omnicom, Inc.
501 Church St. NE
Suite 304
Vienna, VA 22180
703-281-1135

ISO

International Standards
Organization
1, Rue de Varembe
Case Postale 56
CH-1211 Geneva 20
Switzerland
41 22 34 12 40 (tel.)

EIA

Electronic Industries Assoc.
Standards Sales
2001 Eye Street, N.W.
Washington, D.C. 20006

FERERAL STANDARDS

General Service Administration
Specification DIstribution Branch
Building 197, Washington Navy Yard
Washington, D.C. 20407

National Institute of Standards
and Technology (NIST)
Technology Building 225
Gaitherburg, MD 20899

Military Standards Sales
Navel Publication and Forms Ctr.
Commanding Officer
NPFC 43, 5801 Tabor Ave.
Philadelphia, PA 19120
215-697-3321

U.S. Department of Defense
Washington, DC 20301

IEEE

Institute of Electrical and
Electronic Engineers
345 East 47th Street
New York, NY 10017

Standards Sales: IEEE Service Ctr.
445 Hoes Lane
Piscataway, NJ 08854
212-705-7960

COS

Corporation for Open Systems
1750 Old Meadow Road
Suite 400
McLean, VA 22101
703-883-4572

BELL

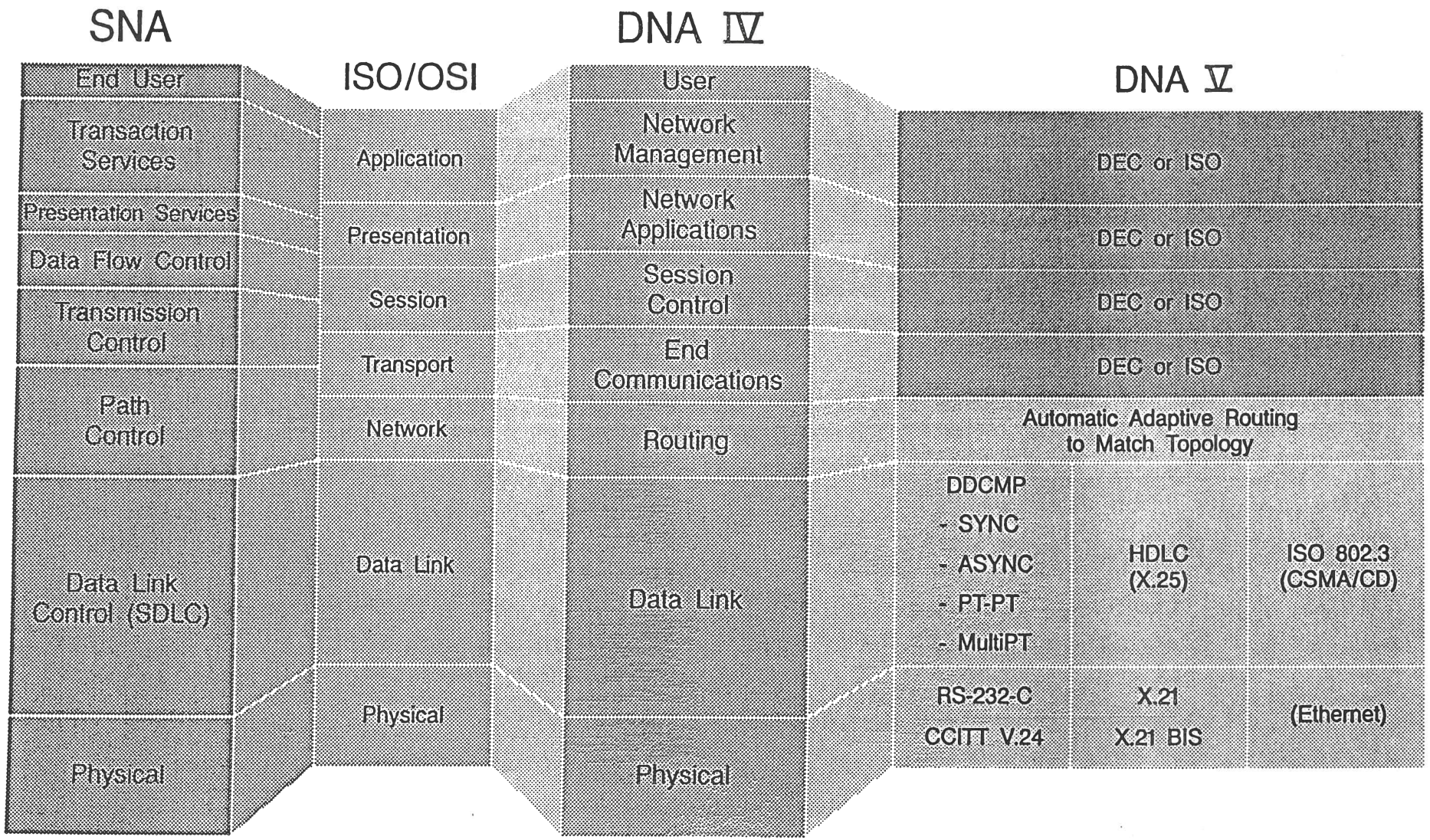
Bell Systems Technical References:

Publishers Data Center
P.O. Box 738
Pratt Street Station
Brooklyn, N.Y. 11205

ECMA

European Computer Manufacturers Assoc.
114 Rue du Rhone
1204 Geneva, Switzerland

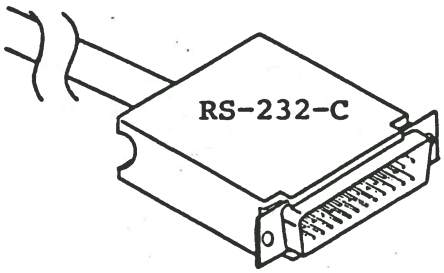
Network Architecture

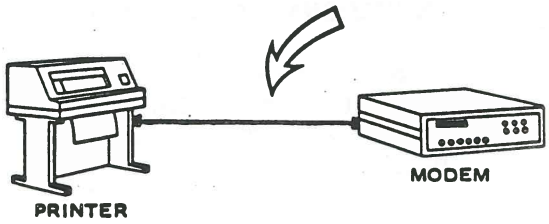


DESCRIPTION OF THE OSI SEVEN LAYERS

LAYER 1. PHYSICAL LAYER

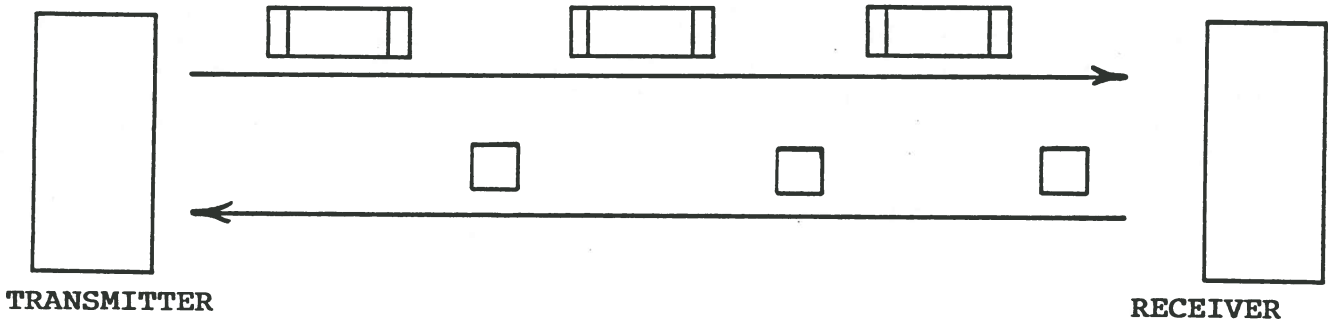
DEFINES SUCH PARAMETERS AS THE ELECTRICAL VOLTAGE LEVELS, BIT SIZES, HALF OR FULL DUPLEX, RULES FOR ESTABLISHING A CONNECTION SUCH AS DIALING A TELEPHONE NUMBER, AND HOW TO END OR BREAK THE CONNECTION. THIS IS AN EASY LAYER TO VISUALIZE BECAUSE THE MOST COMMON FORM IS THE PHYSICAL CABLE CONNECTION BETWEEN THE TERMINAL AND THE MODEM. EXAMPLES ARE THE EIA RS-232-C AND RS-449 OR THE CCITT X.21 STANDARDS.





LAYER 2. DATA LINK LAYER

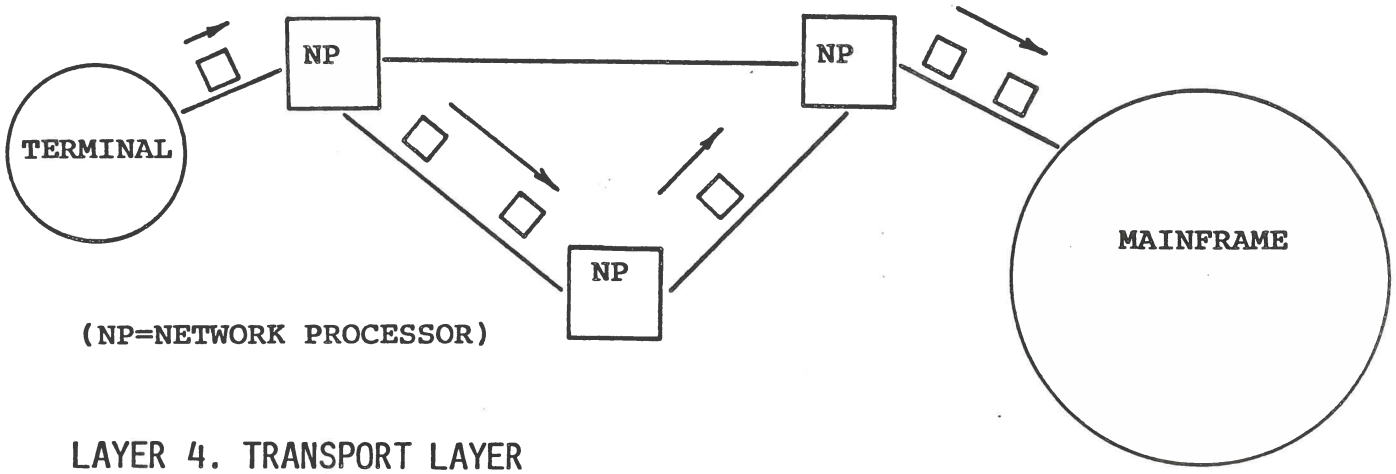
MESSAGES OR DATA RECEIVED FROM LAYER 3 ARE ASSEMBLED INTO SMALLER PIECES CALLED FRAMES OR PACKETS. THESE CONTAIN THE USER DATA SURROUNDED BY TRANSMISSION CONTROL CHARACTERS INCLUDING TRANSMISSION ERROR CONTROL INFORMATION. THESE FRAMES ARE SENT BETWEEN DEVICES ACCORDING TO PRECISE RULES WHICH ALSO DEFINE HOW TO RECOVER FROM A TRANSMISSION ERROR. THIS LAYER REQUIRES SOME LEVEL OF INTELLIGENCE IN THE FEP OR OTHER TERMINAL EQUIPMENT. EXAMPLES OF COMMON PROTOCOLS IN THIS CATEGORY ARE IBM'S SYNCHRONOUS DATA LINK CONTROL (SDLC) AND CCITT'S HIGH LEVEL DATA LINK CONTROL (HDLC) SCHEMES. LOCAL AREA NETWORK IMPLEMENTATIONS - SUCH AS ETHERNET OR TOKEN RING - BREAK THIS LAYER INTO TWO OTHER SUB LAYERS, THE LOGICAL LINK LAYER (LLC) WHICH IS A COMMON LINK TO ANY LAYER THREE ABOVE AND SEPARATE MEDIA ACCESS CONTROL (MAC) LAYERS WHICH ARE UNIQUE TO THE SPECIFIC LAN PROTOCOL BEING USED, SUCH AS TOKEN RING, TOKEN BUS, OR CSMA/CD BUS.



LAYER 3. NETWORK LAYER

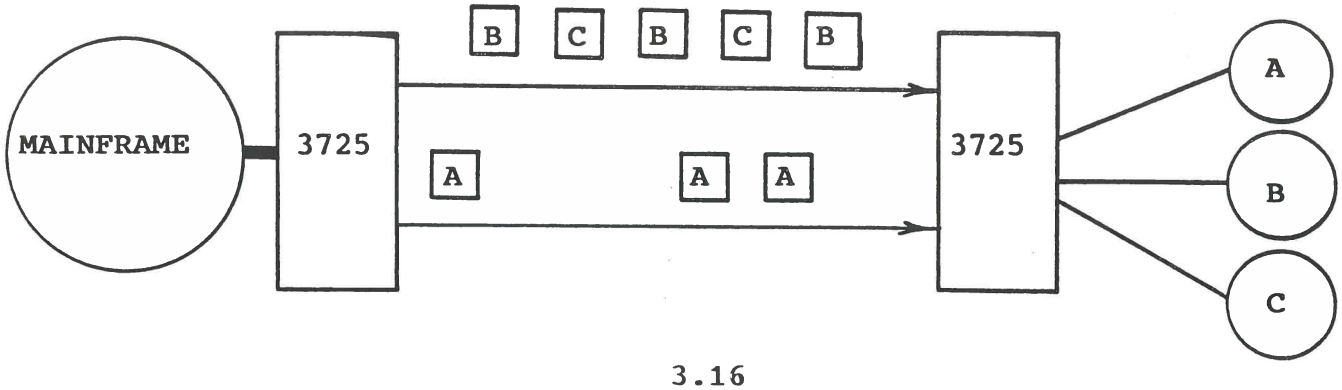
THIS LAYER ACTS AS A TRAFFIC CONTROLLER IN THE NETWORK. IT ASSIGNS DESTINATION OR ROUTE ADDRESSES FROM TABLES, ESTABLISHES A MESSAGE ROUTE IN A COMPLEX NETWORK, INSURES MESSAGE DELIVERY, KEEPS TRACK OF WHAT IS SENT, PRIORITIZES MESSAGES IN THE EVENT TOO MANY ARE RECIEVED AT ONCE, SENDS CONTROL MESSAGES TO ITS PEER LAYERS IN THE NETWORK ABOUT OWN STATUS, REGULATES THE RATE AT WHICH A MACHINE RECEIVES MESSAGES, AND ALLOWS FOR THE INTERCONNECTION OF OTHER NETWORKS.

LAYERS 1-3 ARE OFTEN CALLED THE SUB-NETWORK OR PACKET NETWORK FUNCTION AND CAN BE IMPLEMENTED NOT ONLY AT THE TRANSMITTER AND RECEIVER BUT ALSO IN INTERMEDIATE DEVICES SUCH AS NETWORK PROCESSORS OR PACKET SWITCHING NODES. THE CCITT X.25 PACKET SWITCHING PROTOCOL DEFINES LAYERS 1-3.



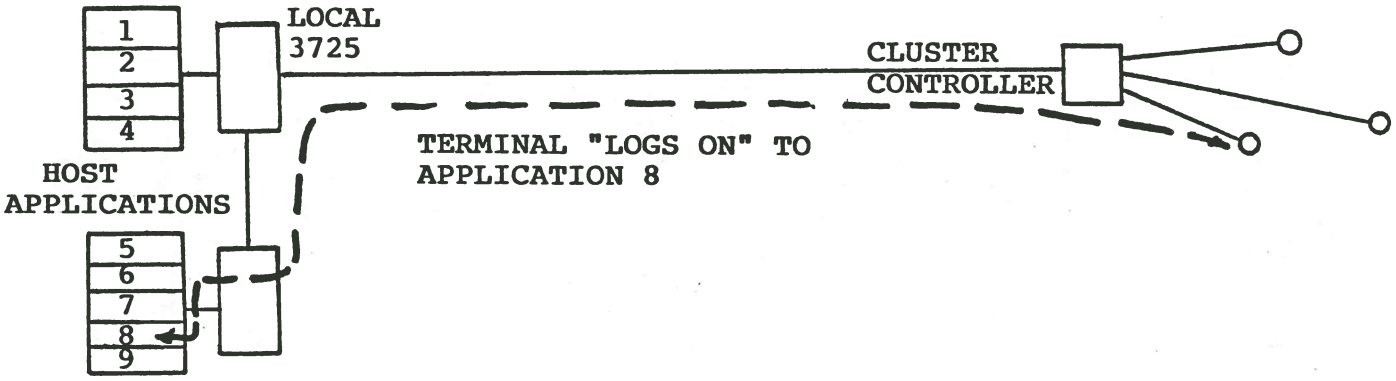
LAYER 4. TRANSPORT LAYER

PROVIDES FOR THE EFFICIENT TRANSMISSION OF MESSAGES THROUGH THE NETWORK. IT INSURES THAT FRAMES ARE DELIVERED IN THE CORRECT ORDER, HAS THE ABILITY TO USE PARALLEL PATHS FOR FAST MESSAGE DELIVERY, USES MULTIPLEXING TO COMBINE FRAMES FROM MANY MESSAGES ONTO ONE PATH, AND CAN BROADCAST MESSAGES TO MANY RECEIVERS. THIS LAYER MAPS USER NAMES TO NETWORK ADDRESSES (USERS RETAIN THE SAME NAME IF THEY MOVE) AND SUPPORTS DATA/MESSAGE RECOVERY FROM MAJOR NETWORK FAULTS SUCH AS A LINE OR NODE OUTAGE BY REROUTING THE PATH OR SAVING THE DATA. THIS LAYER IS USUALLY SOFTWARE BASED AND FOUND IN THE HOST, FEP, INTELLIGENT TERMINALS, AND NETWORK PROCESSORS.



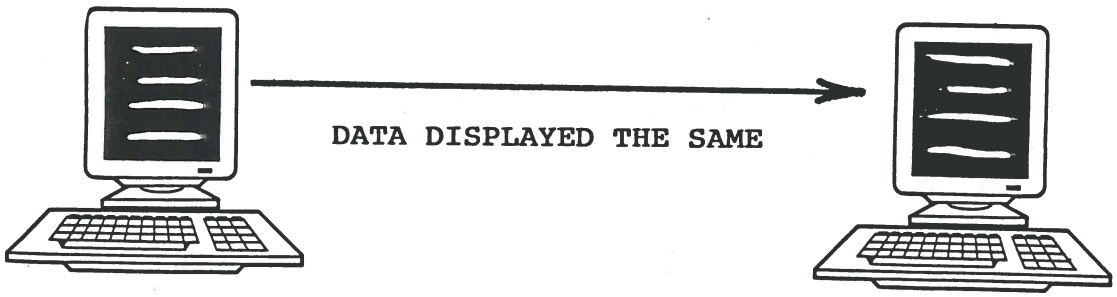
LAYER 5. SESSION LAYER

THIS LAYER IS RESPONSIBLE FOR ESTABLISHING A LOGICAL CONNECTION BETWEEN END USERS. FOR EXAMPLE, A TERMINAL OPERATOR (END USER) LOGS ONTO A PARTICULAR APPLICATION (ANOTHER TYPE OF END USER) IN THE HOST. THIS REQUIRES EASY COMMANDS FOR THE OPERATOR, COMMUNICATING WITH DEVICES IN THE NETWORK TO SET UP THE PROPER PATH, AND ESTABLISHING THE SUPPORT FUNCTIONS IN THE HOST: FILE TRANSFER FEATURES, DATA BASE INTEGRITY, SYSTEM ACCESS SECURITY, MESSAGE ACCOUNTING AND BILLING. EQUALLY IMPORTANT ARE FUNCTIONS THAT ALLOW FOR EFFICIENT SESSION TERMINATION, EVEN IF IT WERE AN ABRUPT TERMINATION DURING A DATABASE UPDATE. THIS HIGH LEVEL LAYER USUALLY INVOLVES THE HOST COMPUTER'S OPERATING SYSTEM SOFTWARE AS WELL AS COMMUNICATIONS SOFTWARE.

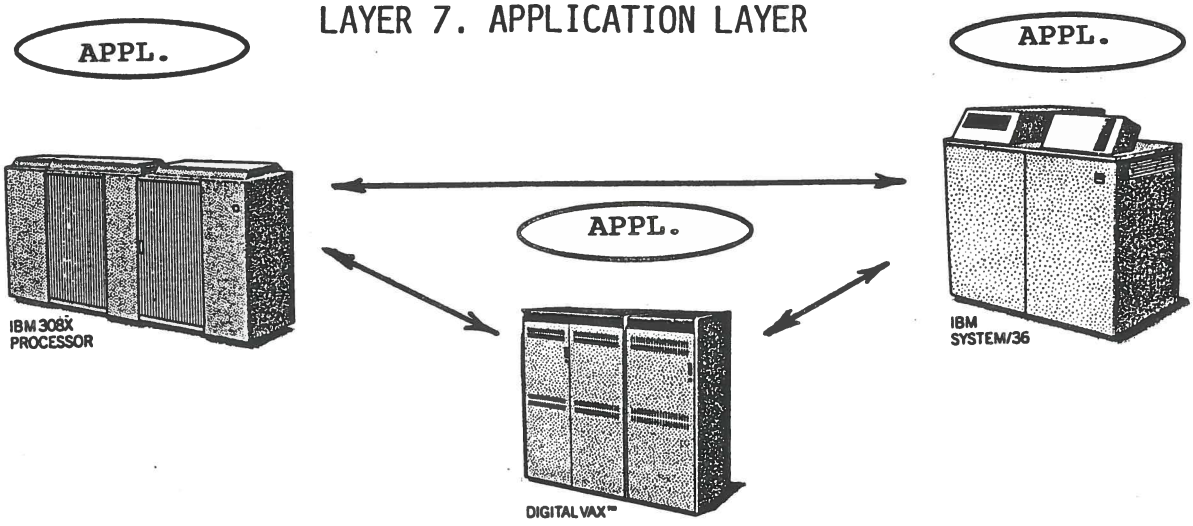


LAYER 6. PRESENTATION LAYER

GENERALLY, FUNCTIONS THAT ARE REQUESTED OFTEN BUT ARE NOT FOUND IN LAYERS 1-5 WILL BE IN THE PRESENTATION LAYER. THIS INCLUDES A SET OF MESSAGE TRANSFORMATIONS OR FORMATING REQUIRED TO PRESENT THE DATA TO END USERS: THE NUMBER OF LINES PER SCREEN, CHARACTERS PER LINE, CURSOR ADDRESSING, CODE CONVERSION, UNIQUE GRAPHIC SYSMBOLS. OTHER FUNCTIONS THAT MIGHT ALSO BE FOUND INCLUDE DATA ENCRYPTION, DATA COMPRESSION, AND TERMINAL EMULATION.



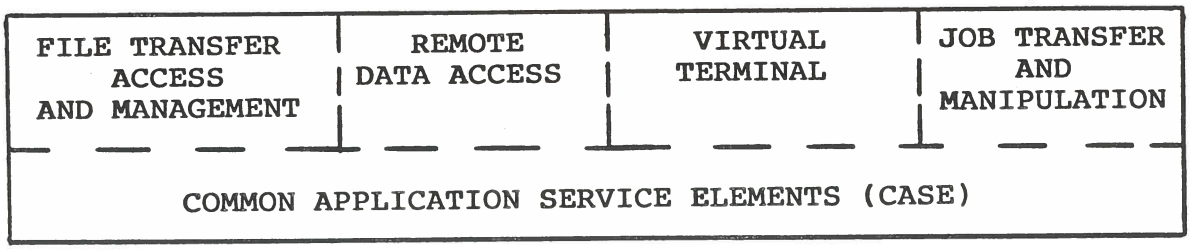
LAYER 7. APPLICATION LAYER



THE APPLICATION LAYER PROVIDES A MEANS FOR APPLICATION PROCESSES TO ACCESS THE SYSTEM INTERCONNECTION FACILITIES - THE LOWER LAYERS - IN ORDER TO EXCHANGE INFORMATION. THIS INCLUDES SERVICES USED TO ESTABLISH AND TERMINATE CONNECTIONS (SESSIONS), AND TO MONITOR AND MANAGE THE SYSTEMS BEING INTERCONNECTED AND THE VARIOUS RESOURCES THEY EMPLOY. THERE ARE MANY DIFFERENT APPLICATIONS SUPPORTED IN THE OSI MODEL REQUIRING THE APPLICATION LAYER TO BE SPLIT INTO TWO PARTS. THE LOWER LAYER - CASE - ARE USED TO PROVIDE COMMON SERVICES NEEDED BY ALL APPLICATION ENTITIES. THIS IS AN INTERFACE TO THE SERVICES THAT ARE PROVIDED TO THE END USER APPLICATIONS.

COMMON SERVICES INCLUDE FILE TRANSFER ACCESS AND MANAGEMENT (FTAM), REMOTE DATABASE ACCESS PROTOCOLS, THE JOB TRANSFER AND MANIPULATION (JTM) SERVICE WHICH ALLOWS A WORK ORDER TO BE SENT TO MANY DIFFERENT NODES IN WHICH JOBS CAN BE EXECUTED. A VIRTUAL TERMINAL SERVICE ALLOWS MANY DIFFERENT KINDS OF TERMINAL TYPES TO LOG INTO DIFFERENT NODES OF AN OSI NETWORK.

THE APPLICATION LAYER MAY ALSO IMPLEMENT OTHER SERVICES NOT COVERED IN THE LOWER LAYERS, SUCH AS RESOURCE USAGE TRACKING, USER ACCOUNTING, AND NETWORK DIAGNOSTICS.



SUBLAYERS IN THE APPLICATION LAYER

MODEM TYPES

ASYNCHRONOUS SYNCHRONOUS	HALF DUPLE FULL DUPLEX	LONG HAUL LIMITED DISTANCE
TWO WIRE FOUR WIRE	DIAL-UP LEASE LINE	VIOCE GRADE WIDE BAND

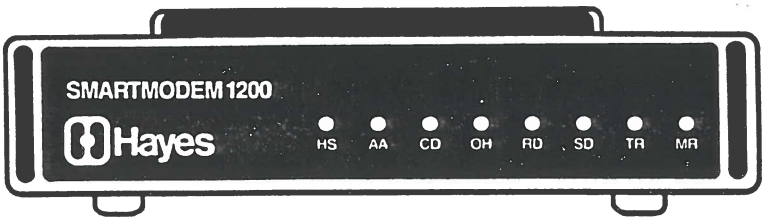
STANDARDS DEFINE MODEM FEATURES AND MODULATION TECHNIQUE

GENERAL MODEM STANDARDS

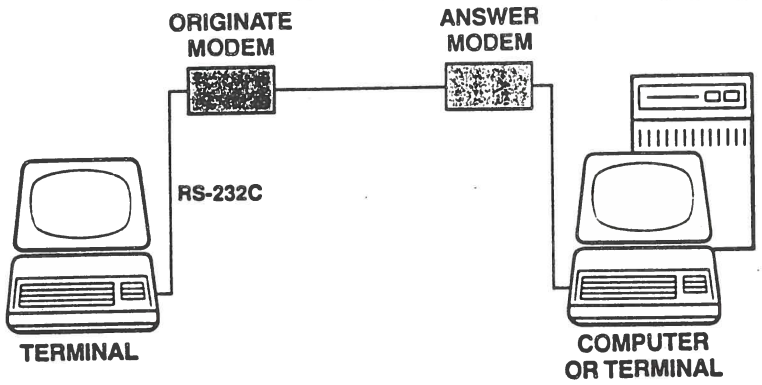
SPEED	TYPE	BELL	CCITT
300 bps	ASYNCHRONOUS FDX, HDX 2/4 WIRE LEASE/DIAL	103 (103,101,108,113)	V.21 NOT COMPATIBLE
0-1200 bps (1800 bps)	ASYNCHRONOUS HDX TWO WIRE FDX FOUR WIRE LEASE/DIAL	202	V.23 NOT COMPATIBLE
1200 bps (300 bps)	ASYNCHRONOUS HDX/FDX 2/4 WIRE LEASE/DIAL	212A	V.22 MOSTLY COMPATIBLE
2400 bps	SYNCHRONOUS ASYNCHRONOUS FOUR WIRE LEASE/DIAL DIRECT CONNECT	201	V.26 CAN BE COMPATIBLE
4800 bps	SYNCHRONOUS 4 WIRE LEASED 2 WIRE DIAL	208 208B	V.27 NOT COMPATIBLE
9600 bps	SYNCHRONOUS 4 WIRE LEASED	209	V.29 (V.32 DIAL) NOT COMPATIBLE
14,400 bps	SYNCHRONOUS 4 WIRE LEASED	-	V.33
19,200 bps	SYNCHRONOUS 4 WIRE LEASED	-	-
24,000 bps	"	-	-

BELL = WESTERN ELECTRIC CCITT = CONSULTATIVE COMMITTEE FOR TELEPHONE AND TELEGRAPH

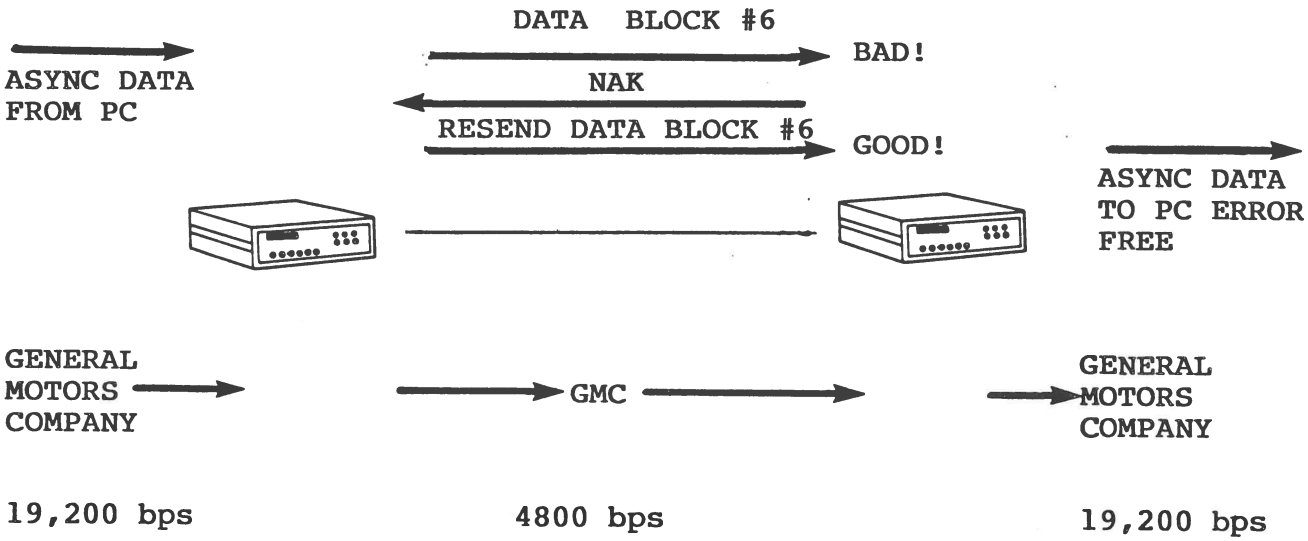
ADVANCED MODEM FEATURES



"Smart" modem means it accepts commands from the terminal/PC to perform function or set initial operational parameters... Dial a number, switch to full duplex, set speed to 2400 bps, etc.



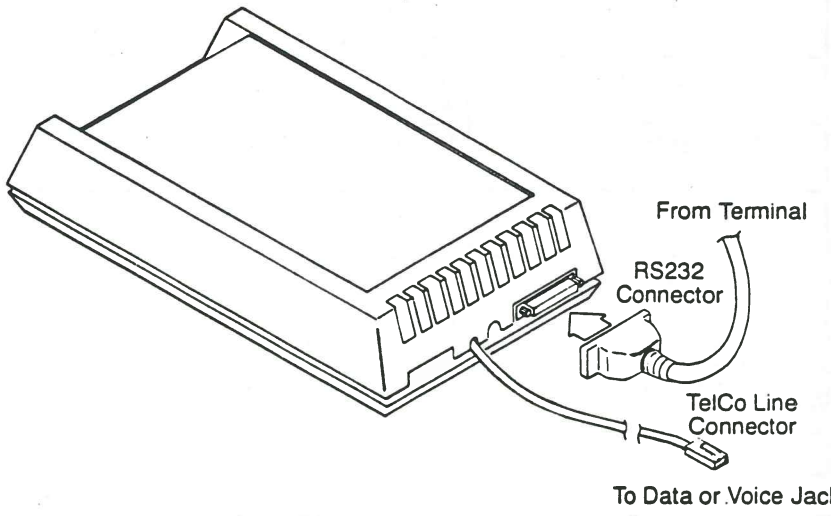
ERROR CHECKING/DATA COMPRESSION MODEMS



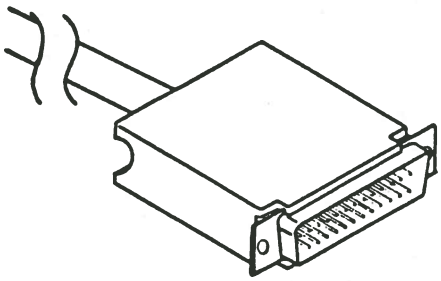
CONNECTING TO THE TERMINAL END

MODEM CONNECTIONS

A MODEM IS USED TO CONNECT A TERMINAL TO THE DIAL-UP NETWORK. DIRECT CONNECT MODEMS DO NOT NEED A TELEPHONE AND THEREFORE ATTACH TO THE NETWORK WITH A STANDARD MODULAR TELEPHONE JACK. THIS TYPE OF MODEM CAN DIAL A NUMBER AND ALSO ANSWER ANOTHER DATA CALL AUTOMATICALLY. LESS EXPENSIVE MODEMS MAY REQUIRE A CONNECTION TO A TELEPHONE SET IN ORDER TO ESTABLISH A CALL.



TERMINAL CONNECTIONS



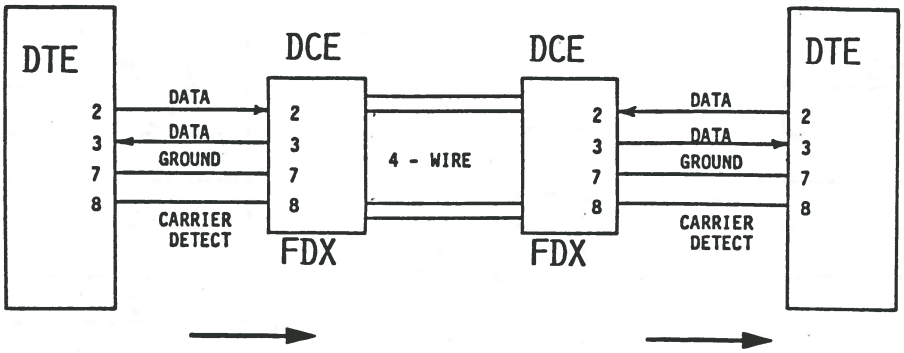
Pin	Function	Pin	Function	Pin	Function
1	Frame Ground	10	Negative dc Test Voltage	19	Sec. Request To Send
2	Transmitted Data	11	Unassigned	20	Data Terminal Ready
3	Received Data	12	Sec. Data Carrier Detect	21	Signal Quality Detect
4	Request To Send	13	Sec. Clear To Send	22	Ring Indicator
5	Clear To Send	14	Sec. Transmitted Data	23	Data Rate Select
6	Data Set Ready	15	Transmitter Clock	24	Ext. Transmitter Clock
7	Signal Ground	16	Sec. Received Data	25	Busy
8	Data Carrier Detect	17	Receiver Clock		
9	Positive dc Test Voltage	18	Receiver Dibit Clock		

THE TERMINAL CONNECTION TO THE MODEM IS DEFINED BY THE ELECTRONIC INDUSTRIES ASSOCIATION (EIA) SPECIFICATION - RS 232 C. THIS INTERFACE STANDARD DEFINES THE USE OF A 25 PIN CONNECTOR AND THE PIN ON WHICH EACH SIGNAL IS PLACED. SEVERAL OF THESE SIGNALS IN SEQUENCE ARE REQUIRED BETWEEN THE TERMINAL AND THE MODEM IN ORDER TO TRANSMIT OR RECEIVE DATA. THE TERMINAL CONTROLS DATA FLOW WHILE THE MODEM MONITORS THE CIRCUIT FOR DATA SIGNALS AND "CARRIER" (BASIC REFERENCE SIGNAL REQUIRED FROM THE REMOTE TERMINAL'S MODEM). ALL OF THE 25 PINS OR SIGNALS DO NOT HAVE TO BE ACTIVE, USUALLY 5-10 IS ALL THAT IS REQUIRED FOR SIMPLE INTERFACES. ADDITIONAL SIGNALS PROVIDE MORE ADVANCED FEATURES.

Interface Pin-out Comparison.

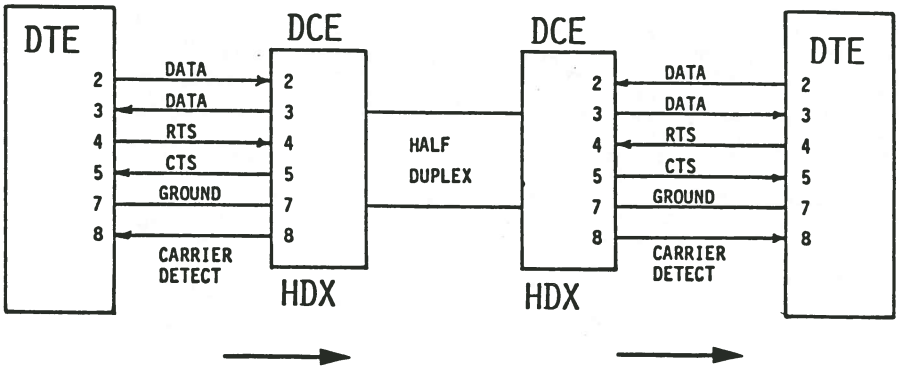
RS232C/CCITT V.24	CCITT V.35	RS449	
25 Pin	34 Pin	37 Pin	9 Pin
1—Protective Ground	A—Protective Ground	1—Shield 37—Send Common	1—Shield 9—Send Common
2—Transmitted Data	P—Transmit Data (A) S—Transmit Data (B)	4—Send Data (A) 22—Send Data (B)	
3—Received Data	R—Received Data (A) T—Received Data (B)	6—Received Data (A) 24—Received Data (B)	
4—Request to Send	C—Request to Send	7—Request to Send (A) 25—Request to Send (B)	
5—Clear to Send	D—Clear to Send	9—Clear to Send (A) 27—Clear to Send (B)	
6—Data Set Ready	E—Data Set Ready	11—Data Mode (A) 29—Data Mode (B)	
7—Signal Ground	B—Signal Ground	19—Signal Ground	5—Signal Ground (C)
8—Carrier Detect	F—Receive Line Signal Detect	13—Receiver Ready (A) 31—Receiver Ready (B)	
9—Reserved for Testing	m—Reserved for DSU Testing		
		20—Receive Common	6—Receive Common
10—Reserved for Testing		10—Local Loop (A) 14—Remote Loop (A)	
11—Unassigned		3—SPARE 21—SPARE	
12—Sec. Carrier Detect		32—Select Standby	2—Sec. Receiver Ready
13—Sec. Clear to Send			8—Sec. Clear to Send
14—Sec. Transmitted Data			3—Sec. Send Data
15—Transmit Clock (DCE Source)	Y—TX Signal Element Timing o—TX Signal Element Timing	5—Send Timing (A) DCE Source 23—Send Timing (B) DCE Source	
16—Sec. Received Data			4—Sec. Received Data
17—Receive Clock	V—RX Signal Element X—RX Signal Element	8—Receive Timing (A) 26—Receive Timing (B)	
18—Unassigned		18—Test Mode (A) 28—Term in Service (A) 34—New Signal	
19—Sec. Request to Send			7—Sec. Request to Send
20—Data Terminal Ready		12—Terminal Ready (A) 30—Terminal Ready (B)	
21—Signal Quality Detector		33—Signal Quality (A)	
22—Ring Indicator		15—Incoming Call (A)	
23—Data Signal Rate Selector		2—Signaling Rate Indicator (A)	
		16—Signaling Rate Selector (A)	
24—Transmit Clock (DTE Source)		17—Terminal Timing (A) 35—Terminal Timing (B)	
25—Busy		36—Stand by Indicator	

RS-232-C INTERFACE OPERATIONS - EXAMPLES



SIMPLE CASE OF TWO FULL DUPLEX DEVICES:

IN A FULL DUPLEX SYSTEM SIMPLY PASSING DATA, A MINIMAL NUMBER OF EIA SIGNALS ARE REQUIRED: TRANSMIT DATA (PIN 2), RECEIVE DATA (PIN 3), CARRIER DETECT (PIN 8), AND GROUND (PIN 7). THE CARRIER IS ENERGY SENT FROM A MODEM AND IS MONITORED BY THE OTHER MODEMS ON THE LINE. IN A FULL DUPLEX POINT-TO-POINT SYSTEM, BOTH ENDS CAN SEND AND RECEIVE AT THE SAME TIME AND, THEREFORE, ENERGY IS SENT FROM THE MODEMS SIMULTANEOUSLY. CARRIER IS ALWAYS PRESENT WHICH CAUSES THE MODEM TO PUT VOLTAGE (RAISE THE LEAD HIGH) ON PIN 8. AN ACTIVE CARRIER DETECT SIGNAL IS REQUIRED TO ALLOW THE TERMINAL TO DISTINGUISH BETWEEN DATA COMING IN ON PIN 3 OR JUST NOISE. THE TERMINAL CAN FREELY SEND OUT DATA ON PIN 2.



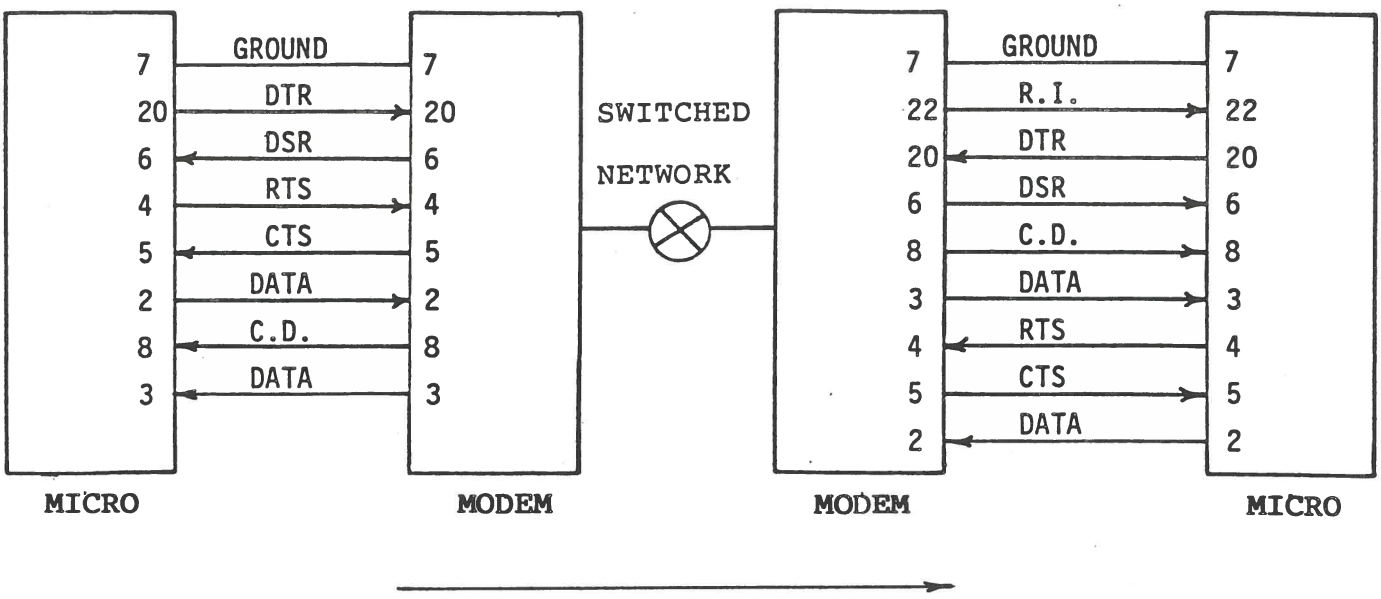
SIMPLE CASE OF TWO HALF DUPLEX DEVICE:

TWO CONTROL SIGNALS ARE REQUIRE IN ADDITION TO CARRIER DETECT IN ORDER TO DETERMINE THE DIRECTION OF TRANSMISSION: REQUEST-TO-SEND (RTS PIN 4), CLEAR-TO-SEND (CTS PIN 5). THE FIRST DEVICE THAT WISHES TO TRANSMIT "RAISES" THE RTS LEAD TO THE MODEM. AFTER A DELAY TO ALLOW THE MODEMS TIME TO DETECT CARRIER AND EQUALIZE, THE MODEM RAISES THE CTS LEAD, WHICH TELLS THE TERMINAL THAT IT IS O.K. TO TRANSMIT NOW. AFTER TRANSMISSION OF THE APPROPRIATE DATA SEGMENT (BLOCK OR FRAME) THE TERMINAL LOWERS RTS, CAUSING THE MODEM TO TURN OFF CARRIER.

PIN 6 DATA SET READY (DSR) IS MADE HIGH BY THE DCE WHEN TURNED ON. PIN 20 DATA TERMINAL READY (DTR) IS MADE HIGH BY THE DTE WHEN IT IS TURNED ON. THESE INDICATE TO THE OTHER THAT THEY ARE READY TO GO.

OPERATIONS OF THE RS-232-C INTERFACE

EXAMPLE USING AUTO-DIAL/AUTO-ANSWER MODEMS



•THERE IS A CONVERSATION WHICH TAKES PLACE BETWEEN THE TERMINAL (DTE) AND THE MODEM (DCE) EACH TIME DATA IS TRANSMITTED OR RECEIVED. A DIAL-UP SYSTEM USING AUTO-DIAL/AUTO-ANSWER MODEMS PROVIDES A GOOD EXAMPLE OF THIS CONVERSATION.

•TO INITIATE A CALL THE TERMINAL PLACES A VOLTAGE SIGNAL ON PIN 20 (DTR - DATA TERMINAL READY). THIS CAUSES THE MODEM TO DIAL THE TELEPHONE NUMBER OF THE RECEIVING TERMINAL. AT THE RECEIVING END THE MODEM "HEARS" THE RING AND PLACES VOLTAGE ON PIN 22 (RI - RING INDICATOR). IF READY, THE REMOTE TERMINAL TELLS THE MODEM TO "ANSWER THE PHONE" BY PLACING A SIGNAL ON PIN 20 (DTR). THIS MODEM WILL THEN SEND AN ANSWER TONE DOWN THE LINE TO THE TRANSMITTING MODEM WHICH IN TURN TELLS THE TRANSMITTING TERMINAL THAT THE PHONE WAS ANSWERED BY PLACING A VOLTAGE ON PIN 6 (DSR - DATA SET READY).

•THE PROCESS OF TRANSMITTING DATA CAN NOW BEGIN. THE TRANSMITTING TERMINAL CAN NOW TELL ITS MODEM TO GET READY TO SEND DATA BY PLACING VOLTAGE ON PIN 4 (RTS - REQUEST TO SEND). THE MODEM WILL IN TURN START SENDING CARRIER, OR A REFERENCE SIGNAL, TO THE REMOTE MODEM. AFTER A SHORT PERIOD OF TIME, THE MODEM TELLS THE TRANSMITTING TERMINAL THAT IT'S ALRIGHT TO TRANSMIT BY PLACING VOLTAGE ON PIN 5 (CTS - CLEAR TO SEND). THE TERMINAL THEN SENDS THE DATA OUT OVER PIN 2 TO THE MODEM WHICH IN TURN MODULATES THE DATA SIGNAL AND TRANSMITS IT ACROSS THE LINE.

•THE REMOTE MODEM'S JOB DURING THIS PERIOD IS TO DETECT CARRIER, INFORM ITS TERMINAL THAT DATA IS COMING BY PLACING VOLTAGE ON PIN 8 (CD - CARRIER DETECT), AND WAIT FOR THE DATA TO ARRIVE. WHEN IT DOES, THE MODEM DEMODULATES IT INTO DIGITAL FORM AND SENDS IT TO THE TERMINAL OVER PIN 3.

•WHEN THE TRANSMITTING TERMINAL HAS FINISHED SENDING ITS STRING OF DATA IT MUST GIVE THE OTHER TERMINAL A CHANCE TO RESPOND ON THIS HALF DUPLEX LINE. IT DOES THIS BY REMOVING THE VOLTAGE FROM PIN 4 (RTS) WHICH CAUSES THE MODEM TO STOP SENDING CARRIER FREEING THE LINE FOR THE OTHER TERMINAL TO USE.

•IN A FULL DUPLEX SYSTEM, WHERE BOTH TERMINALS CAN SEND AND RECEIVE SIMULTANEOUSLY, THERE IS NO NEED TO TAKE TURNS SHARING THE LINE AND; THEREFORE, THE OPERATIONS ARE MUCH MORE SIMPLE. THE CD VOLTAGE WOULD BE "ON" ALL THE TIME ON BOTH ENDS INDICATING THAT THE TELEPHONE CONNECTION BETWEEN THE TWO TERMINALS WAS WORKING BUT THERE WOULD BE NO NEED FOR THE RTS/CTS SIGNALS. USING MANUAL DIAL MODEMS, THERE WOULD BE EVEN FEWER SIGNALS PASSED BETWEEN THE MODEMS AND THE TERMINALS.

•IN GENERAL, IT'S IMPORTANT TO KNOW THAT THIS TYPE OF CONVERSATION TAKES PLACE WHENEVER DATA IS TRANSMITTED AND THAT THE PINS AND WIRES IN THE RS 232 C INTERFACE HAVE A SPECIFIC FUNCTION WHICH MAY VARY FROM SYSTEM TO SYSTEM.

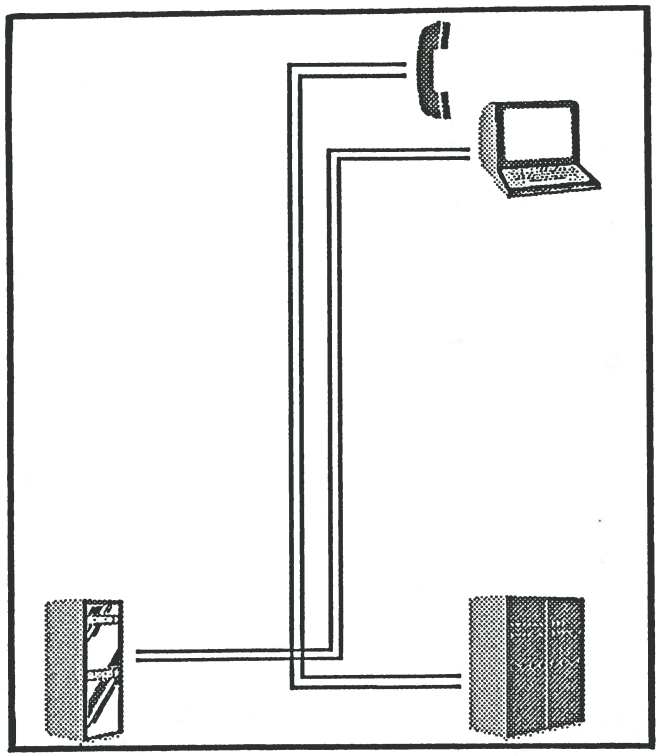
SECTION 4.0

WIRING AND DISTRIBUTION

Twisted Pair Wire

UTP - 4 M bps UP TO 1000 Ft, 16 M bps UP TO 500 Ft:

STP - 4 M bps UP TO 2000 Ft, 16 M bps UP TO 1000 Ft.



Computer

Telephone System

Twisted pair wire

Standard telephone wire

TYPICAL: IBM TYPE 3 CABLE
AWG 22/24
UNSHIELDED TWISTED PAIR (UTP)
COMMON APPLICATIONS, INEXPENSIVE

Twisted shielded wire

Better for data transmission

TYPICAL: IBM TYPE 1 CABLE, 2 PAIRS 22 AWG
SHIELDED TWISTED PAIR (STP)

REQUIRED FOR ELECTRICALLY NOISY AREAS

UNIQUE TO IBM SYSTEMS, EXPENSIVE

TWISTED PAIR IN-HOUSE WIRE

TWISTED PAIR WIRE is one common wire type found in buildings and is used to transmit data, voice, telephone set control signals, alarm signals, and even video. It is basic telephone wire in either 24, 22, 20, or 18 wire gauge size with pairs twisted to reduce interference. The number of twists per foot is usually standard in the United States to mostly offset the 60 hz electrical power induced interference. For improved protection from outside interference, especially required for very high speed data transmission, the pair of wires are often wrapped with aluminum backed plastic or braided metal shield, which is called TWISTED SHIELDED PAIR. The shields are grounded to drain off the interference.

There is a standard technique for routing twisted pair wire within the building. There is often a main hub, called the MDF (Main Distribution Frame), which is the focal point for all in-house wire and external circuits entering the building. The MDF is a series of jumper blocks with to/from sides on them. Jumper pins are placed across the block to complete a circuit from one wire to another. This facilitates changes in circuit connections and reduces the need to move or add physical wire.

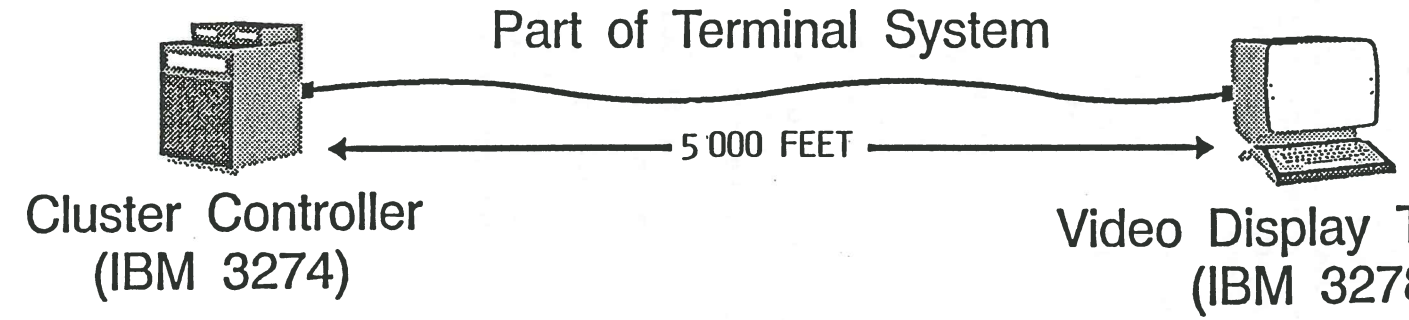
Large cables with hundreds of wires run between the MDF and several IDF (Intermediate Distribution Frames) in key locations throughout the building, called TELEPHONE CLOSETS. The IDF extends the connection concept at the floor level to further facilitate changes. In new building wiring installations today, a common practice is to install 8-PAIRS PER STATION to each desk to accommodate many current and future needs, including local area networks (discussed later).

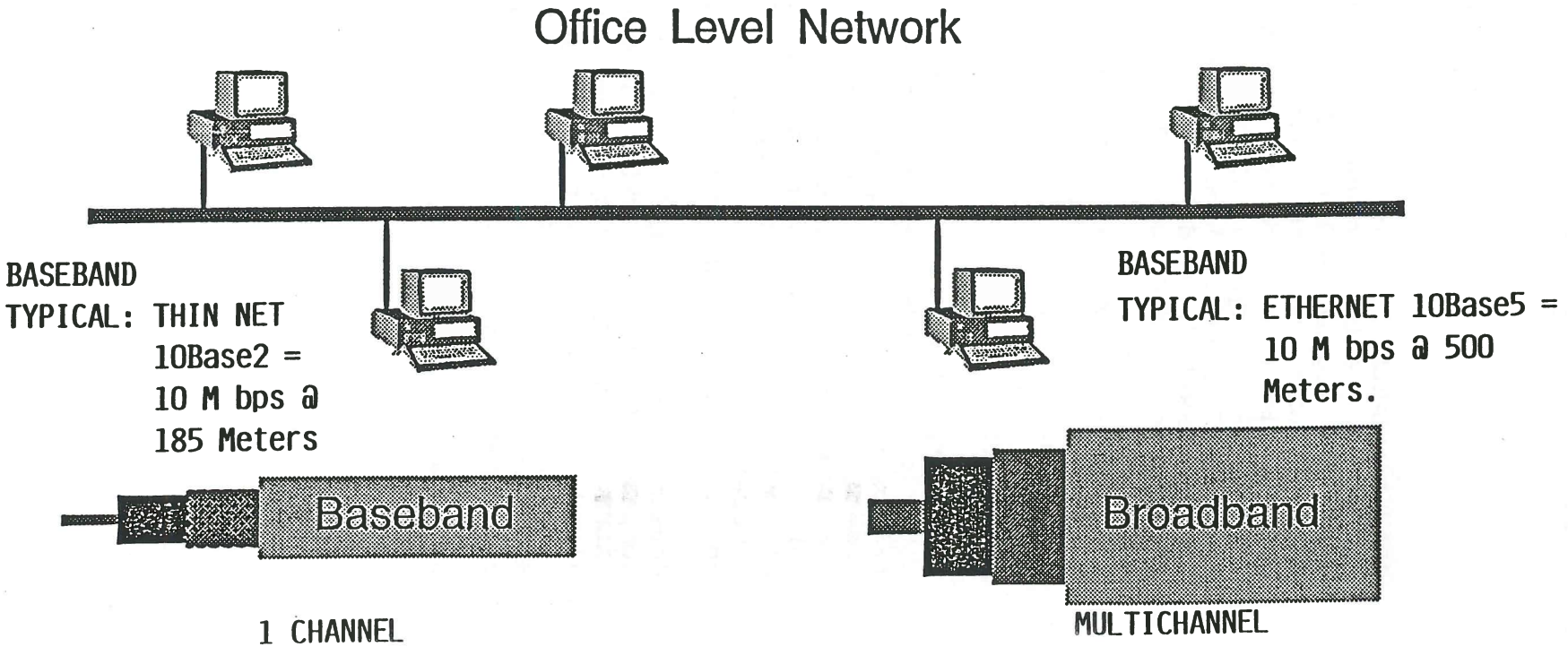
Like all physical wire there is a close relationship between the wire type, the data transmission speed (or signal frequency), and the distance the signals can travel over the wire and still be recognized. Telephone wire, twisted pair wire, and twisted shielded wire generally are at the low end in terms of speed and distance. Twisted pair wire has been used to carry 4 million bits per second over 1000 feet. Very new technology has extended this to 16 million bits per second up to 500 feet. On the design table are capabilities to extend UTP use at 100 million bits per second up to 100 feet.

Unshielded twisted pair (UTP) wire should be used in situations where the Electromagnetic Interference (EMI) are low as this can interfere with the data signals on the wire. Good design guidelines are as follows for minimum distances from the wire to:

- 5 inches from a power line 2k volt or less.
- 12 inches from flurescent lighting and power lines at between 2 and 5k volts.
- 36 inches from power lines more than 5k volts.
- 40 inches from transformers and motors.
- Avoid running UTP near sources of RF sources of radiation, radio broadcast and computer equipment.
- Don't use in environments running large motors, welders air compressors, industrial ovens, combustion engines.

Coaxial Cables





COAXIAL CABLES

COAXIAL CABLE is used for the transmission of very high speed data over greater distances than twisted shielded pair wire with very good signal quality. Coax, as it is called, is made up of a solid center conductor with a good shielding around it. It is used for in-house wire to connect a CRT terminal with its CLUSTER CONTROLLER - a typical IBM 3270 INFORMATION DISPLAY SYSTEM or IBM 8100 SYSTEM; it is used to connect processors together such as the IBM SERIES/1; and it is a very popular transmission media for LANs (Local Area Networks discribed later).

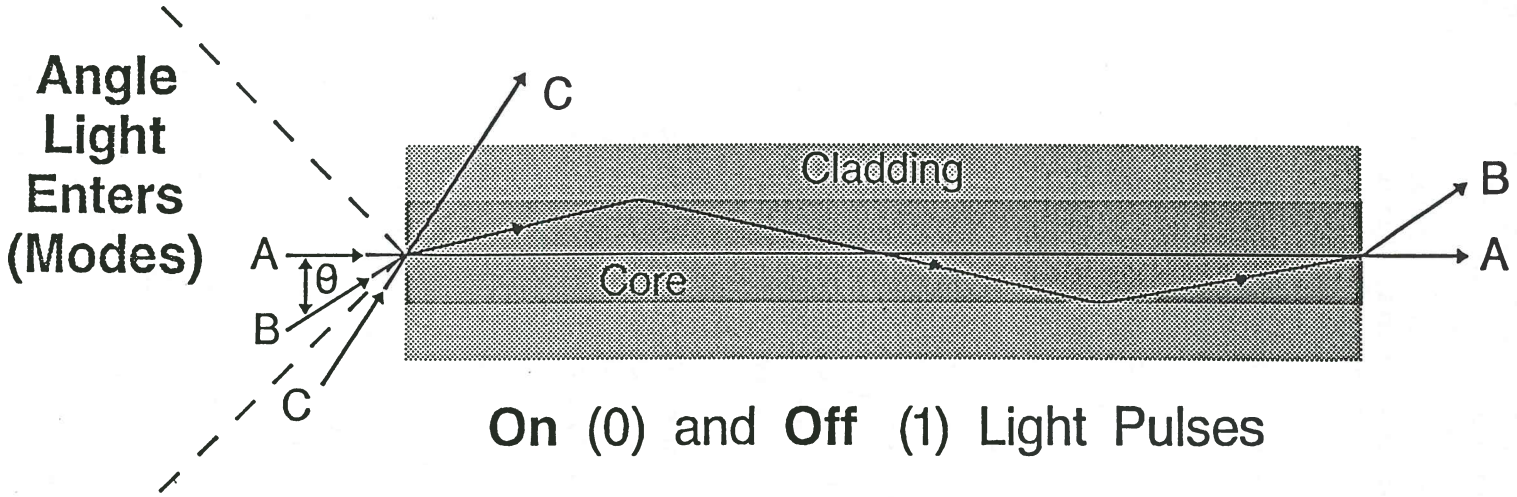
BASEBAND cable has a thin solid center conductor and usually a braided metal shielding. This construction easily supports data rates in excess of 10 M (million) bps over distances of 8000 feet. A single CHANNEL, that is only one logical transmission, is supported at a time.

BROADBAND coax cable has a thick center conductor and a solid, heavy metal shield around it which results in a cable that can transmit very high frequencies over great distances. Broadband is sometimes called CATV or cable TV wire as it has been used for those purposes for over twenty years. Like cable TV, broadband cable when used for data transmission supports multiple channels of information. This may include several data channels plus several closed circuit TV or video conferences, off-air TV, and voice channels. LAN channels can each handle over 10 M bps.

Coax is generally thicker wire and more difficult to install compared to twisted pair. In recent years, a device called a BALUN (BALanced/UNbalanced impedance matching device) is used to allow twisted pair wire to replace the baseband coax link. A BALUN at the equipment end of each link is installed on the coax jack and twisted pair wire used in between; however, this often cuts down the maximum distance between the equipment.

Broadband is very thick and requires skilled installers.

Fiber Optic Transmission

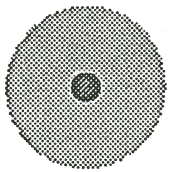


On (0) and **Off** (1) Light Pulses

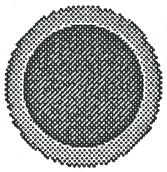
Light Transmitter Converter

(FDDI LAN/MAN; 100 M bps @ 2 k Meters BETWEEN REPEATERS)

Light Receiver Converter



Single Mode Fiber



Multimode Fiber

FIBER OPTIC TRANSMISSION

Fiber optic cables have significantly greater data handling capacity than copper based cables and are immune to electrical interference, which means that they have much lower data error rates especially at high speed. Fiber is used in-house to support LANs and direct terminal connections, around campuses to connect buildings together, and by telephone companies to provide long distance circuits.

Fiber is most effective when used to connect large sources of data traffic together, such as two corporate office buildings within a city. Data rates of tens to hundreds of millions to billions of bit per second over thousands of miles are common. While initially expensive for wiring to the desk-top, advances in the technology of creating and splicing the fibers has placed it in range of copper based wiring techniques for desk-top to desk-top installations.

Transmission of data through the fiber is handled by sending a series of on/off light pulses from one end to another. The fiber is constructed of two glass materials with different reflective qualities. The outside layer or cladding reflects light well while the inside layer lets light pass easily. A laser light source produces high speed pulses of light, representing logical 1 and 0 bits, that bounce through the fiber and are detected at the other end. They are then converted back to electrical signals for use by digital equipment.

MULTIMODE fiber lets in light at many angles which causes many different light streams to bounce around and interfere with each other reducing the capacity/distance factor. SINGLE MODE fiber limits the light mode to achieve very high speed data rates over long distances.

SINGLE MODE FIBER HAS HIGHER BANDWIDTH BUT AT THE EXPENSE OF HIGHER MATERIAL AND INSTALLATION COSTS. ADDITIONALLY, SINGLE MODE FIBER REQUIRES TRANSMISSION EQUIPMENT THAT USES EXPENSIVE LASER DIODES AS A LIGHT SOURCE, WHILE MULTIMODE CAN OPERATE WITH EQUIPMENT THAT UTILIZES LOW-COST, HIGHLY RELIABLE LEDs AS TRANSMITTERS. IT IS ALSO MUCH EASIER AND THEREFORE LESS COSTLY TO TERMINATE, CONNECTORIZE, AND SPLICE MULTIMODE FIBER DUE TO THEIR LARGE CORE DIAMETER.

MULTIMODE FIBER COMES IN SEVERAL VARIETIES AND IS CHARACTERIZED BY CORE AND CLADDING DIAMETERS: 100/140, 100/125, 85/125 and 62.5/125 CORE AND CLADDING DIAMETERS, EXPRESSED IN MICROMETERS) ARE COMMON WITH 62.5/125 THE MOST SUITABLE IN PREMISE DISTRIBUTION SYSTEMS. ITS RELATIVELY SMALL CORE DIAMETER (62.5 microns) PROVIDES HIGH BANDWIDTH BUT EASY TO USE. IT IS BECOMING THE STANDARD TYPE BY MANUFACTURERS AND IS THE MEDIA OF CHOICE FOR THE FDDI SYSTEMS, PROVIDING A GOOD MIGRATION PATH FOR THE FUTURE.

ROUTE TO:
Mgr. Voice Operations _____
Mgr. Data Operations _____

OPERATIONS QUARTERLY...

INFORMATION AND COMMENTARY ON
VOICE AND DATA COMMUNICATIONS
OPERATIONS MANAGEMENT

McGuire Consulting

EDITED BY:
JAY D. McGUIRE

VOLUME NO. 28 DATE: SEPTEMBER 1, 1990

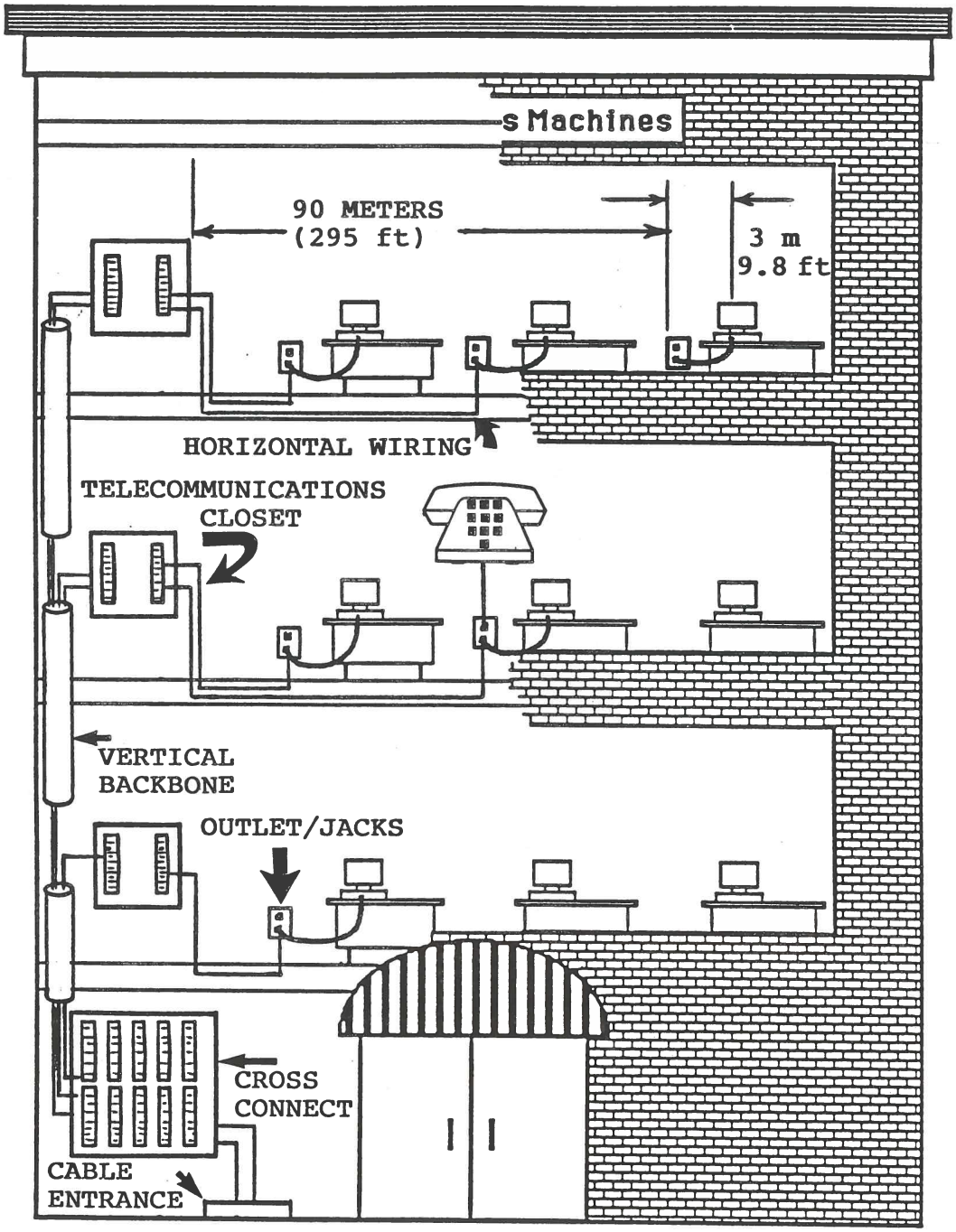
BUILDING WIRING STANDARDS

The Commercial Building Wiring Standard for Telecommunications Pathways and Spaces defines uniform, vendor-independent voice/data wiring systems. These guidelines for cable plant design and building construction are voluntary and may become U.S. standards in January 1991. They are the culmination of five years' work by the Telecommunications Industry Association (TIA) and the Electronic Industry Association (EIA). These specifications are intended to help users rewire existing structures and cable new buildings up to 10 million square feet and are expected to have a useful life of more than 10 years. The standard addresses horizontal office wiring and the jacks used, telecommunications wiring closets, backbone wiring, and the placement of intermediate and main distribution frames or cross-connects. Additionally, it is intended to offer an alternative to cabling schemes such as AT&T's Premise Distribution System (PDS) and IBM's Cabling Systems as well as structured wiring systems from MOD-TAP Systems, AMP, Inc., and Anixter Bros. Inc.

The overall plan is based upon a three level hierarchical star topology with maximum cable distances specified for each leg to accomodate wire and connection signal loss and electromagnetic interference for four types of cable. The plan for horizontal cabling calls for a minimum of two office jacks (wall outlet connections) and use of an eight-pin (four pair) modular jacks and standard coaxial cable connectors. One of two jacks in the outlet will be supported by a cable containing four pairs of 24 gauge, 100-ohm, unshielded twisted pairs (UTP) while the second can be supported using one of three types of media. These include four pair, 100-ohm UTP cable, two pair 150-ohm shielded twisted pair (STP) cable, or a 50-ohm coaxial cable. Telecommunications closets and equipent rooms are recommended to follow EIA/TIA -569 standard.

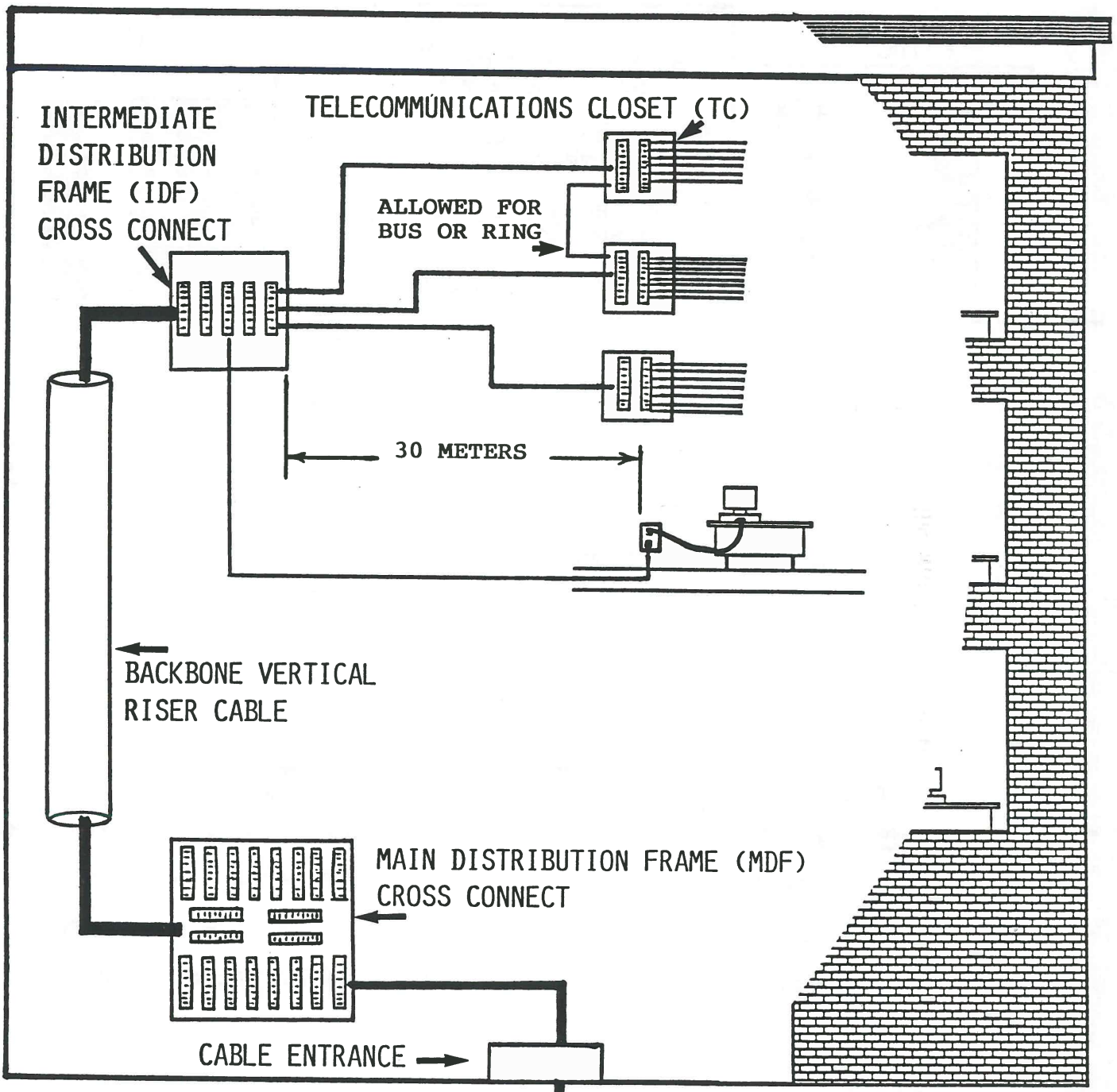
While star-based local area networks and other systems are easily supported, ring and bus based topologies can also be accommodated. Cable/distance specifications can also support most LAN types on the market.

HORIZONTAL WIRING



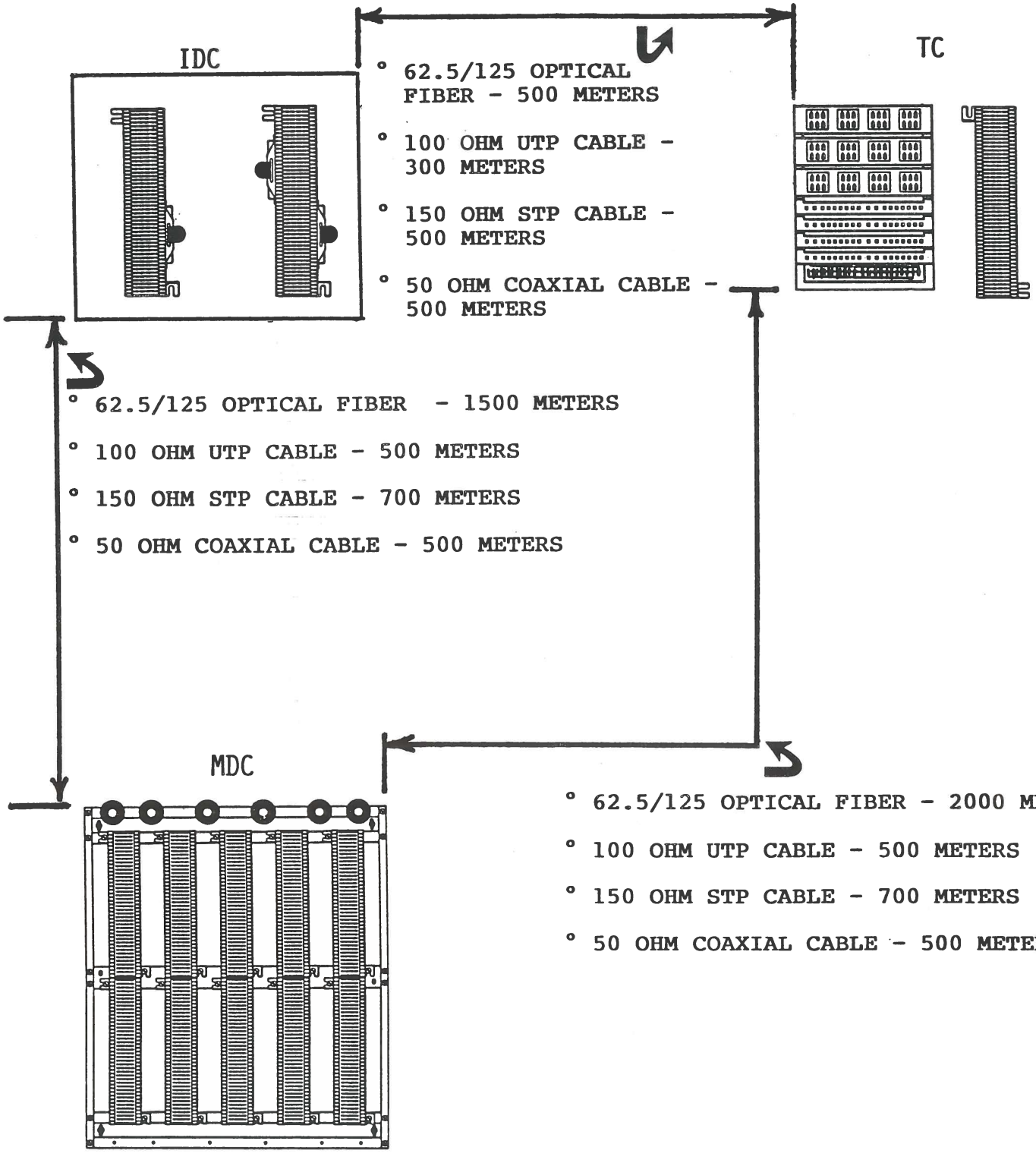
1. NO MORE THAN ONE TRANSITION POINT BETWEEN DIFFERENT FORMS OF THE SAME TYPE OF CABLE (FLAT TO ROUND).
2. NO BRIDGED TAPS (MULTIPLE APPEARENCES OF THE SAME CABLE PAIR AT SEVERAL DISTRIBUTION POINTS).
3. MAXIMUM HORIZONTAL RUN OF 90 METERS REGARDLESS OF WIRE TYPE.
4. CROSS CONNECTS AND JUMPERS OR PATCH CORDS COUNT IN THE CABLE LENGTH TOTAL CONSIDERATION.
5. RECOMMEND SINGLE SHEATH PER APPLICATION (SEPARATE VOICE AND DATA) TO MINIMIZE CROSSTALK.

DISTRIBUTION HIERARCHY



THE BACKBONE CABLE SYSTEM CONSISTS OF VARIOUS TYPES OF TRANSMISSION MEDIA, IDF, MDF, MECHANICAL TERMINATIONS AND INTERBUILDING ENTRANCES. EACH TELECOMMUNICATIONS CLOSET IS WIRED TO AN MDF OR IDF CROSS CONNECT. EXCEPTIONS TO THIS RULE ARE TO SUPPORT LAN BUS OR RING TOPOLOGIES WHICH MAY REQUIRE SOME DIRECT TC-TO-TC RUNS. ONLY TWO CROSS CONNECT LEVELS. INTERCONNECTIONS BETWEEN ANY TWO CLOSETS MUST PASS THROUGH THREE OR LESS CROSS CONNECTS AND ONLY A SINGLE CROSS CONNECT CAN BE PASSED TO REACH THE MDF. NO BRIDGED TAPS. WORKSTATIONS CAN CONNECT DIRECTLY TO A CROSS CONNECT. THE MAXIMUM CABLE LENGTHS DEPEND ON TYPE OF CABLE USED AND HOW IT IS CONNECTED.

BACKBONE CABLING DISTANCES



UNSHIELDED TWISTED PAIR SPECIFICATIONS

° COMPATIBLE TO IBM TYPE 3 CABLE, AT&T's PDS AND ISDN CABLE TYPES WHICH CAN GENERALLY HANDLE UP TO 10 M bps DIGITAL DATA OR VOICE.

° APPLICABLE STANDARDS GROUPS:
ANSI/ICEA - AMERICAN NATIONAL STANDARDS INSTITUTE/INSULATED CABLE ENGINEERING ASSOCIATION PUBLICATION S-80-576-1988.
NEC - NATIONAL ELECTRICAL CODE AND LOCAL BUILDING CODES.
ASTM - AMERICAN SOCIETY FOR TESTING MATERIALS SPECIFICATIONS D-4565-1986, D-4566-1986.

° 24 AWG (AMERICAN WIRE GAUGE) SOLID COPPER, THERMOPLASTIC INSULATED CONDUCTORS FORMED INTO FOUR INDIVIDUAL TWISTED PAIRS, TWO TWISTS PER FOOT, ENCLOSED IN THERMOPLASTIC OR PLENUM-RATED JACKET.

° MAXIMUM DIAMETER OVER INSULATION - 1.22 mm (0.048 inch); OF COMPLETE CABLE - 6.25 mm (0.25 inch).

° BREAKING STRENGTH OF COMPLETE CABLE - 40.82 kilogrtams (90 lbs) MINIMUM; MUST WITHSTAND A BEND RADIUS OF 25.4 mm (1 inch) MAXIMUM WITHOUT JACKET OR INSULATION CRACKING. [MAXIMUM SAFE PULLING TENSION SHOULD NOT EXCEED 11.34 kilograms (25 lbs)].

° USOC COLOR CODE:

1st PAIR:	WHITE-BLUE AND BLUE
2nd PAIR:	WHITE-ORANGE AND ORANGE
3rd PAIR:	WHITE-GREEN AND GREEN
4th PAIR:	WHITE-BROWN AND BROWN

° MAXIMUM D.C. RESISTANCE: 28.6 OHM/1000 feet

° MUTUAL CAPACITANCE: 17 picofarads/1000 feet

° CHARACTERISTIC IMPEDANCE: 100 ohms +/- 15%

° MAXIMUM ATTENUATION (DISTORTION AND SIGNAL LOSS)

@ 1 M hz	-8 dB/1000 feet
@ 4 M hz	-16 dB/1000 feet
@ 10 M hz	-30 dB/1000 feet
@ 16 M hz	-40 dB/1000 feet

° FOR USE IN THE BACKBONE VERTICLE SYSTEM THE ONE-SHEATH-ONE-APPLICATION RULE MAY BE VARIED TO ACCOMMODATE 25 PAIR CABLES, WHICH IS GENERALLY ADVISED TO AVOID CROSSTALK, ESPECIALLY BETWEEN VOICE AND DATA PAIRS. OFTEN IT IS TOO EXPENSIVE IN THE BACKBONE TO USE INDIVIDUAL CABLES. SOME SYSTEMS, SUCH AS THE IEEE 10BASET LAN STANDARD, ARE DESIGNED TO BE USED ON A 25 PAIR CABLE. THERE ARE OTHER TECHNIQUES WHICH CAN BE USED TO SUPPORT THE USE OF 25/50/100 PAIRS CABLES: ISOLATE APPLICATIONS BY SIGNAL TYPE IN THE CABLE RUN AND USE DIFFERENT TWIST RATES OF PAIRS WITHIN THE CABLE. BEST TO USE MULTIPLE 25 PAIR CABLES THAN ONE 100 PAIR CABLE.

OTHER CABLE SPECIFICATIONS

SHIELDED TWISTED PAIR

° COMPATIBLE WITH IBM TYPE 1 AND 2 CABLE WHICH CAN HANDLE 16 M bps.

° 22 AWG SOLID COPPER, THERMOPLASTIC INSULATED CONDUCTORS, FORMED INTO TWO INDIVIDUALLY TWISTED, FOIL SHIELDED PAIRS. OVERALL BRAIDED SHIELD ENCLOSED IN THERMOPLASTIC OR PLENUM RATED JACKET.

° MAXIMUM OUTSIDE DIAMETER: 0.43 inches FOR COMPLETE CABLE.

° MINIMUM BEND RADIUS: 3.0 inches.

° UNBALANCED CAPACITANCE IS 1500 picofarads/kilometer @ 1k hz.

° CHARACTERISTIC IMPEDANCE: 150 ohms +/- 10%

° MAXIMUM ATTENUATION:

@ 4 M hz	-6.4 dB/1000 feet
@ 16 M hz	-12.2 dB/1000 feet

50 OHM COAXIAL CABLE

° IEEE 802.3-1989 (10BASE-5) SPECIFICATION.

OPTICAL FIBER CABLE - BACKBONE VERTICAL SECTION.

° MULTIPLE, GRADED INDEX OPTICAL FIBER WAVEGUIDE.

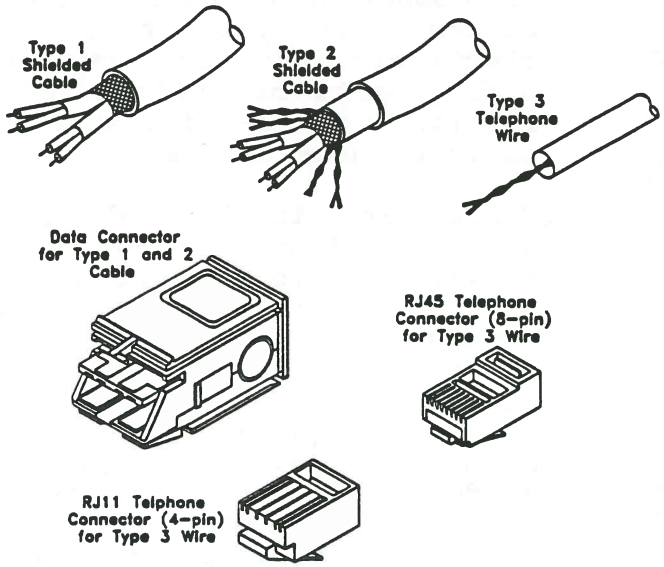
° NOMINAL 62.5/125 micrometers CORE/CLADDING DIAMETERS.

° PERFORMANCE:

WAVELENGTH (NANOMETERS)	MAXIMUM ATTENUATION	MINIMUM INFORMATION TRANSMISSION
850	4.0 dB/kilometer	160 M hz - kilometer
1300	1.5 dB/kilometer	500 M hz - kilometer

VENDOR CABLING SCHEMES

IBM TYPE CABLE:



TYPE 1

Braided cable shield around two twisted pairs of # 22 AWG conductors for data communication

TYPE 2

Same as type 1 cable with the addition of four twisted pairs of # 22 AWG wire for voice.

TYPE 3

Two unshielded twisted pairs of # 22/24 AWG conductors. Requires a media filter for FCC's limits on Radio Frequency Interference (RFI) leakage at high frequencies.

TYPE 5

Two optical fiber conductors with inner/outer diameter widths of 100/140 micros used to connect distant repeaters or MAUs.

TYPE 6

Two twisted pairs of # 26 AWG stranded conductors for data communications used as a patch/jumper cord in wiring closets and limited to 6 feet.

TYPE 8

Undercarpet flat cable of # 26 AWG conductors which have a distance limitation of 50% of type 1 cable.

TYPE 9

Shielded twisted pair cable with #26 AWG conductors used for plenum (air return vents) installations and having a distance limit 66% of type 1 cable.

AT&T'S PREMISE DISTRIBUTION SYSTEM

The AT&T Premises Distribution System (PDS) is a specific cabling plan for a building or campus that connects telephones, data processing equipment, personal computers, PBX's, LANs, and office equipment to each other and to outside networks. PDS is comprised of copper and optical fiber cables, cross connects, terminal blocks and protectors, adapters, connecting blocks, and electronic interface devices which can be used in non-PDS wiring arrangements or collectively to form a coherent PDS system. PDS is organized around a star topology based upon wiring closets and cross connect frames.

There are six defined parts: CAMPUS SUBSYSTEM - Consists of wiring, electrical grounding and protection, and splicing facilities for connecting business equipment in different buildings on the same campus. EQUIPMENT WIRING SUBSYSTEM - Consists of wire connectors and protection support hardware required to link outside cables to the network. ADMINISTRATIVE SUBSYSSTEM - Consists of cross connect hardware, patch cords, and labeling required in the wire closets. BACKBONE RISER - Consists of copper and fiber cable, splice enclosures, and associated hardware to support the main cable routes between wiring closets. HORIZONTAL SUBSYSTEM - Consists of multiple copper pairs, modular adapters, voice/data wall outlets to link the workstation to the wiring closet. WORK LOCATION SUBSYSTEM - Consists of adapters, connectors, and cords needed to link the unique workstation equipment (IBM, WANG, analog/digital phones, etc.) to the wall outlet. This includes extensive use of special Baluns (converter)

CHARACTERISTICS:

° PDS components conform to ISDN standards.

° Universal 8-pin modular outlet for connectivity.

° Common media to support voice and data.

° High speed data up to 10 M bps over unshielded twisated pair and up to 200 M bps over fiber cable.

° Support of multiple vendor terminal equipment.

° Applications for single building or campus environments.

° Extensive use of optical fiber cable to meet future needs.

° Elimination of specialized media such as coaxial cables.

° Migration strategy to total fiber distribution plan.

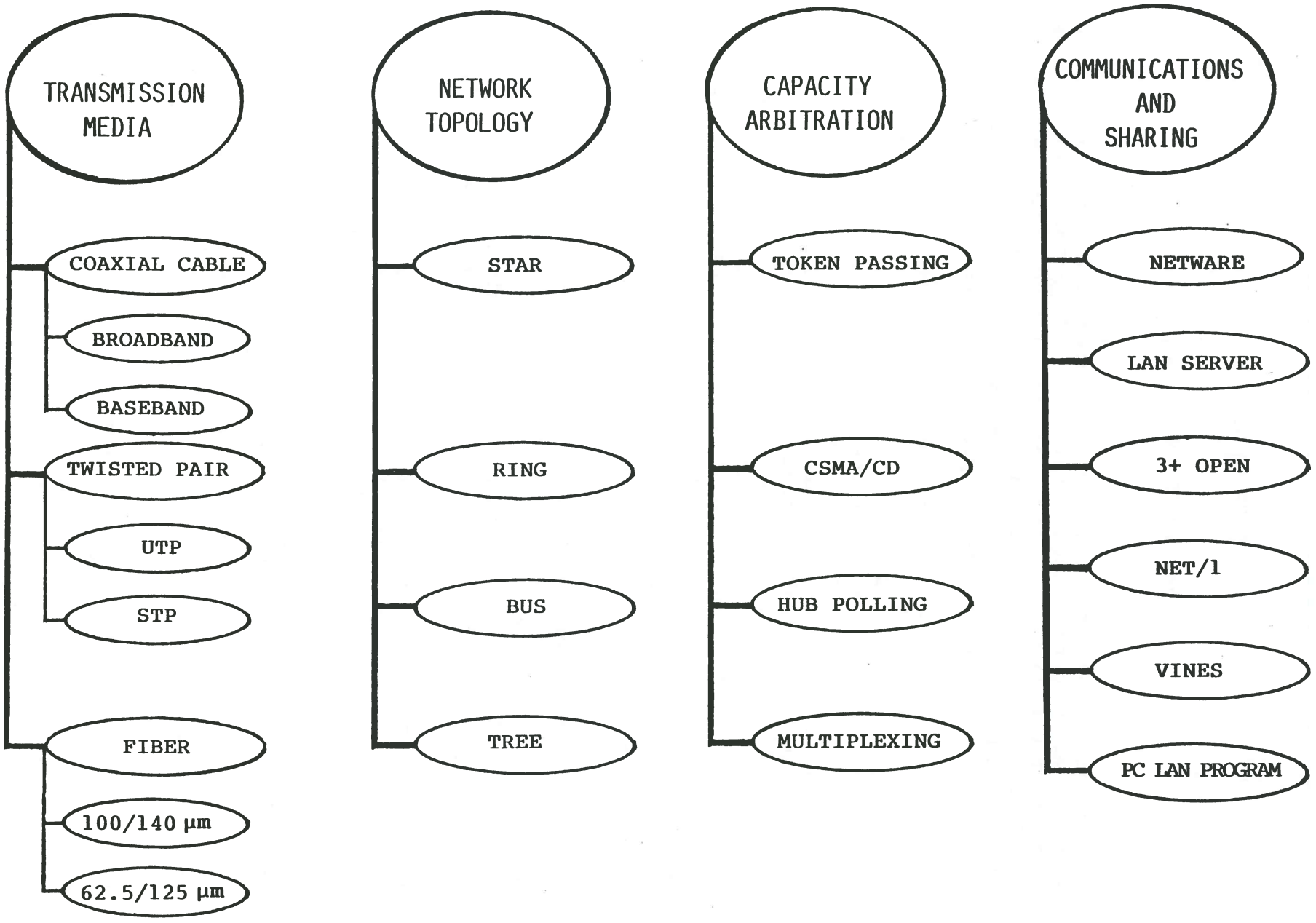
° Low entry cost with a combination of unshielded twisted pair and optical fiber.

° Conforms to the new EIA/TIA wiring standards.

SECTION 5.0

PC LOCAL AREA NETWORKS

LOCAL AREA NETWORK ATTRIBUTES



CASE STUDY

LANs IN DESERT STORM

Marines have long had their own data network, a worldwide Systems Network Architecture net that uses Department of Defense communications satellites for transport and now they have "wired" the desert in Operation Desert Storm. Local area networks based upon Banyan System's Vines network operating system are located in various command centers and positions around Saudi Arabia.

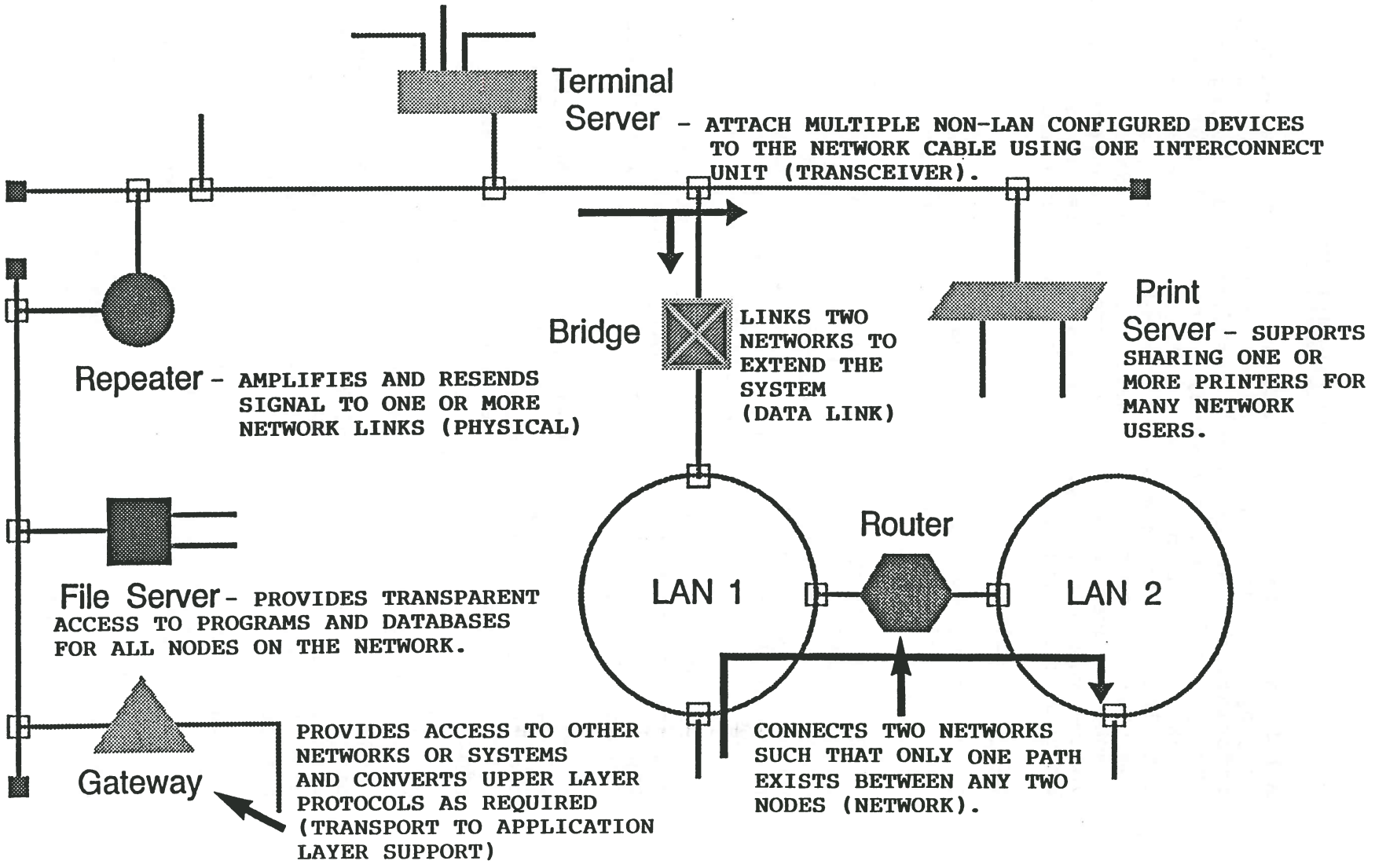
Networking the desert in this case means connecting the LANs with wide-area-networks over military radios - a new approach to say the least. The Marine deployment of LANs was sparked by the users themselves, officers who had used LANs in the U.S. and realized that the nets could also make their work easier in the field. In support of the deployment in the Persian Gulf, the Marines pulled together networks linking special mainframes, IBM PCs, Compaq Computer PCs, clones and a variety of laptops. Moreover, they have repeatedly hooked together, disconnected, packed and reconnected LAN gear when moves were required. Technical specialists and even office staff without much technical background have done the integration. They put together "every piece of gear they could get their hands on..... and that the connectivity has involved tremendous innovation" says a Marine spokeman.

Most data passed between nodes on the Desert Storm LAN involves administrative matters: schedules of parts, troops under the command sector, field promotions, transportation requests and casualty lists. Through the LANs, Marine field units can transmit electronic mail, either within the desert command, or through the Marine WAN, back to the U.S.

The link back to the states involves three satellite hops to the data center in Quantico, VA. One hop goes from the Gulf to Japan, a second hops links Japan to Hawaii and from there the data makes a third hop to Quantico all using SDLC protocols. The persian Gulf data centers are mounted in mobile trucks each carrying an IBM 9377 computer with a 3720 front end processor and varying disk dirves for the Marine headquarters. In the field are 20 plus LANs, mostly token rings but a few Ethernets. Users on the token ring LANs can access data through a 4991 token ring interface while those on the Ethernet must use a 3270 terminal emulation package. Each LAN supports 10 to 15 users maximum to reduce vulnerability.

The LANs use Banyan Vines 4.0 network operating system and are connected to the SNA network through a Soft-Switch, Inc. E-mail gateway, which makes the LAN appear as an SNA distribution system. Information entered on a LAN workstation, say a field promotion, is transmitted through the SNA network to a data base on one of three IBM 3084 mainframes at the Marine's Center in Kansas City, MO. where personnel records are updated.

LAN Components



LAN DEFINITION

A LAN is a data communications network spanning a limited geographical area, a few miles at most. It allows users to share information and computer resources, including mass storage, backup facilities, software, printers, plotters, etc. Typically, a LAN is made up of network interface cards (circuit boards) that fit inside the connected computers, cable to connect these computers, protocol software to move data from computer to computer, user interface software to transparently connect user to network resources, and network operating system software to provide efficient and secure sharing of resources.

LAN COMPONENTS

1. THE CAPACITY ARBITRATION METHOD - is the way the devices share the network transmission system, such as TOKEN PASSING OR CSMA/CD.

2. THE INTERFACE CARD - is the device that connects the computer to the cable. It contains the cable jack, transmission logic, memory, and in some cases it comes with software to interface it to other parts of the LAN logic in the computer. This is where the network control resides. The interface card must be chosen to match the arbitration technique and cable type used.

3. THE LAN OPERATING SYSTEM - is the software that resides in the computer to provide the transparent interface between the user or application and the network. Programs like Novell, 3-COM, or Banyan are examples.

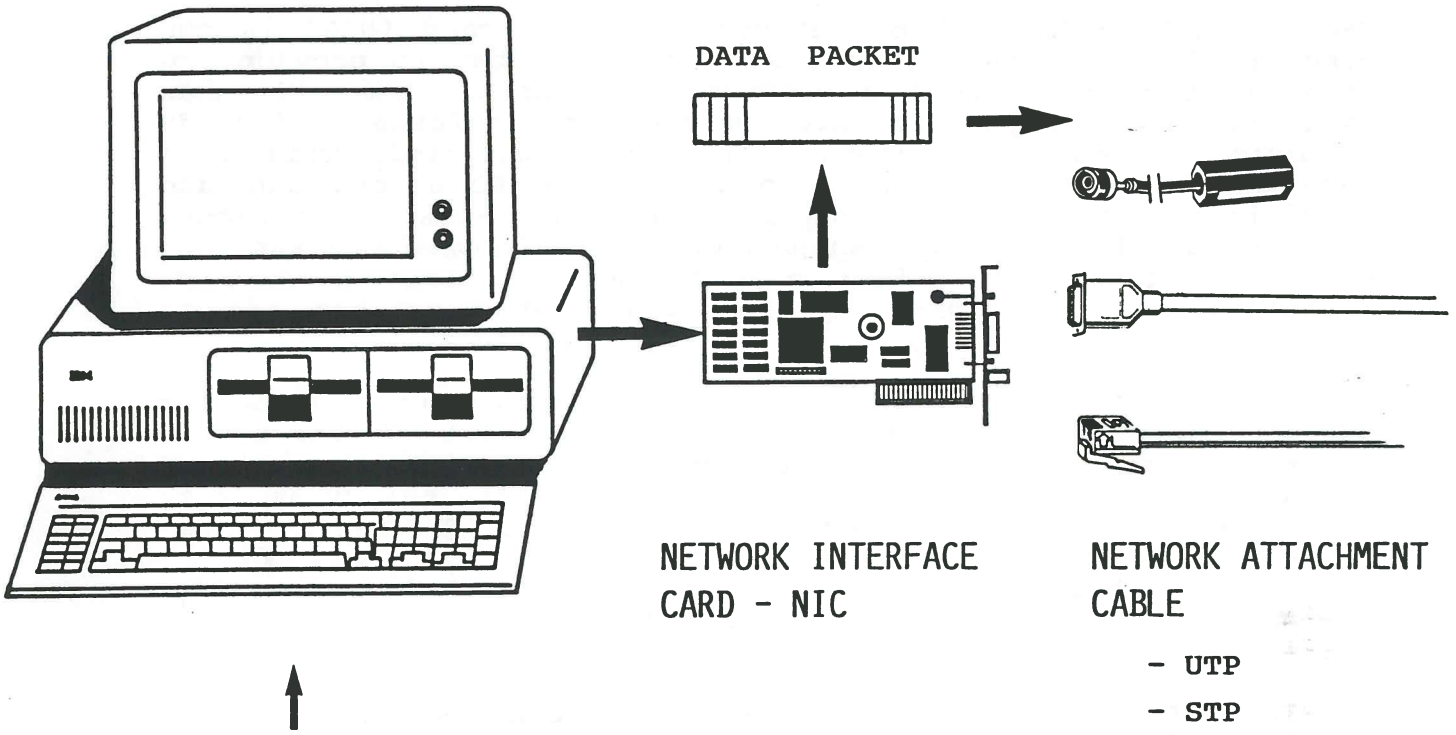
4. FILE SERVER - is a device, a PC, on the network that stores and distributes programs and data files to be shared by users on the network. Often the machine that is used for the file server will also perform as the printer server and provide network administative functions.

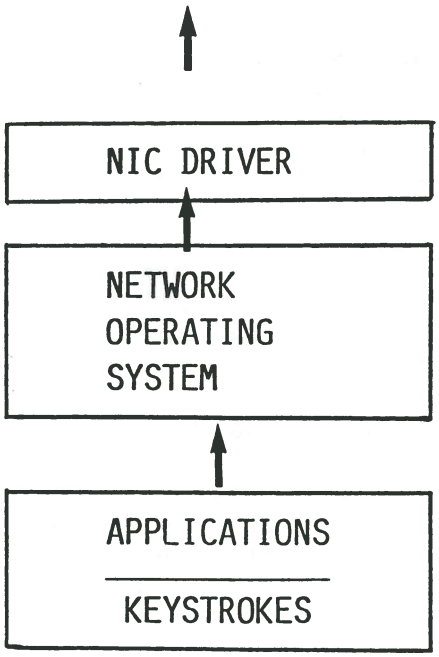
5. BIDGES, ROUTERS AND GATEWAYS - connect LAN networks together. A bridge is able to read the device address on a transmitted packet and pass it on to another network. A router is like a bridge but can decide which is the best way to send a message when there is a choice. A gateway translates information to be used by different types of systems, such as between SNA and OSI networks.

6. LAN SECURITY - covers the methods used to protect the data from corruption by unknowing users, accidents, and intruders. These include physical security, encryption, and passwords.

7. LAN MANAGEMENT - means taking care of the network. Each LAN provides a different level of management tools and capabilities. In addition, external tools such as protocol analyzers and cable testers are often required.

LAN PC REQUIREMENTS





NIC OPTIONS:

- LAN TYPE COMPATIBILITY (ETHERNET, ARCNET, TOKEN RING)
- CABLE TYPE
- COMPUTER TYPE
- BUS ACCESS - 8/16 BIT DMA SHARED MEMORY BUS MASTER ISA/EISA/MCA
- BUFFER SIZE
- DRIVER SUPPORT (COMES WITH NIC) PERFORMANCE, NOS SUPPORT
- 4/16 BIT TOKEN RING VERSION
- SOFTWARE ONBOARD
- NETWORK MANAGEMENT FEATURES

PC LAN INTERFACE CARDS

The LAN INTERFACE CARD or network interface card (NIC) is the piece of hardware that fits inside the computer to provide the physical connection to the network. In general, the NIC takes data from the PC, puts it into the appropriate format and sends it over the cable to another LAN interface card. This card receives the data, puts it into a form the PC understands and sends it into the PC. To accomplish this requires many functions. Buffers must be checked, requests must be acknowledged, sessions must be established, tokens must be sent, collisions must be detected, etc. A summary of the important functions are as follows:

PC TO NIC COMMUNICATIONS which means getting the data to/from the NIC and the computer's memory. There are three methods but one of the most common is the memory mapped I/O. In a memory mapped I/O transfer, the computer's CPU assigns some of its memory space to the I/O device, in this case the interface card. This memory, say 12k out of 640k bytes, is then treated as if it were main memory even though it is physically on the NIC. No special instructions are needed to get the data to/from the card since it is like taking it from one part of main memory to another.

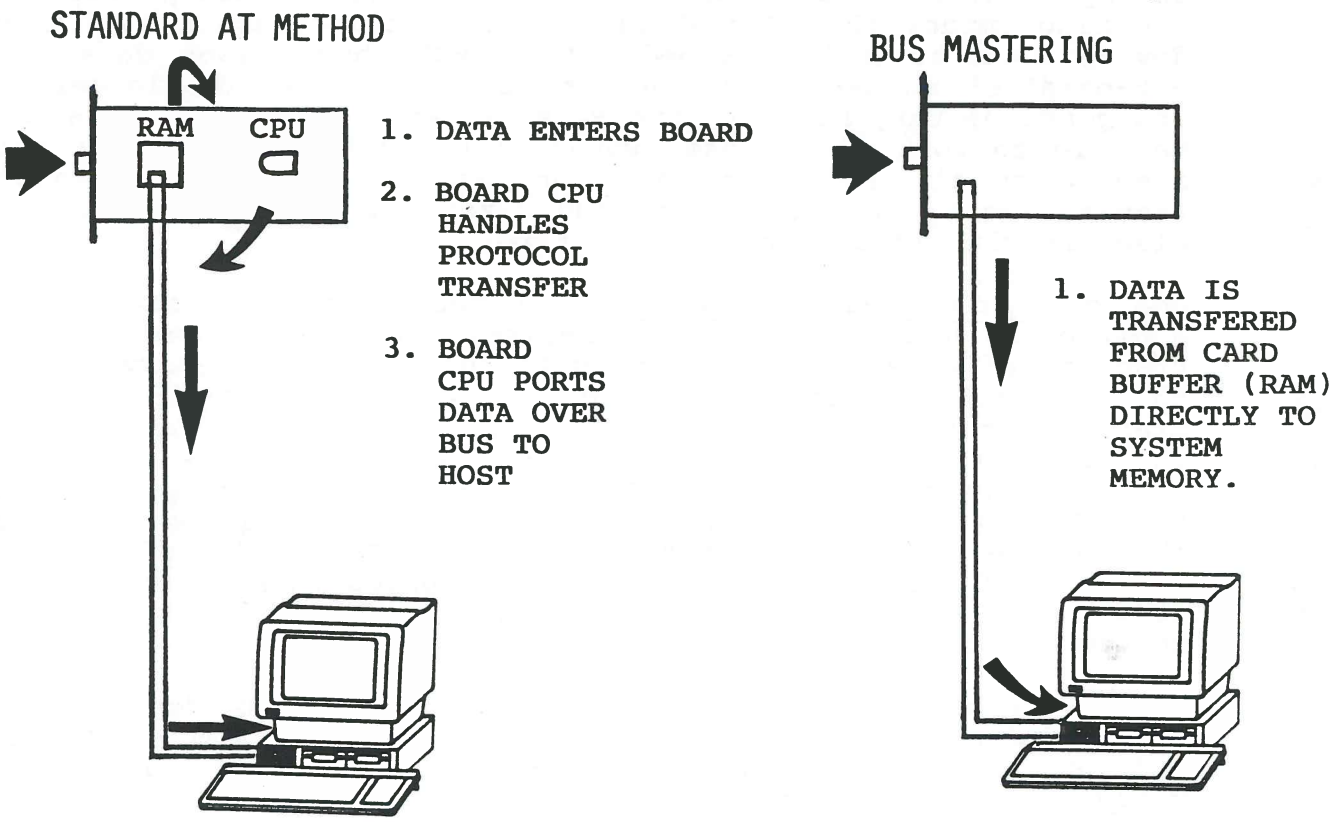
BUFFERING The buffer is a storage area that holds data as it is moving to/from the cable. The purpose is to make up for inherent delays in transmission because some parts of the data transfer are slower than others. Data usually comes into the card faster than it can be converter from serial or parallel, depacketized, read and sent.

PACKET INFORMATION is the most important job of the network and is almost always done by the NIC. Packets are the units of transmission used on most LANs. Files and messages for transmission are broken up into packets as they are sent. At the other end they are put together to reform the original file or message. A packet has three sections: header, data and trailer. The header includes an alert to signal " packet on the way", the packet's source address, destination address, and clock information to synchronize transmission. Some headers also have control fields to direct the packet through the network. The data section contains the end-user information usually with a maximum field size of from 1k to 4k bytes. The trailer contains the error checking CRC information.

CABLE ACCESS means using the appropriate access method such as Token Passing or CSMA/CD. The entire protocol to do this, all the circuitry and firmware (software written into hardware) resides on the NIC. Most of the time there is a chip set that takes care of this, such as the 82586 Ethernet controller. There is also an Arcnet and Token Ring chip set.

Other functions performed by the NIC include PARALLEL-SERIAL CONVERSION, SIGNAL ENCODING/DECODING of the bits into digital signals, and HANDSHAKING, the negotiation with the receiver NIC during session set up as to the best parameters - packet size, number before ACK, etc. - to use.

BUS ACCESS METHODS



4. HOST CPU TRANSFERS DATA TO SYSTEM RAM.

5. SYSTEM RAM PORTS DATA TO APPLICATION.

ADAPTERS THAT USE BUS MASTER TECHNIQUES COMMUNICATE ACROSS THE SYSTEM BUS WITH SYSTEM RAM, BYPASSING THE HOST.

I/O MAPPING - MEMORY ADDRESSES ARE KNOWN TO BOTH THE ADAPTER CARD AND THE APPLICATION. PHYSICALLY, SOME MEMORY MAY BE ON THE ADAPTER BOARD. DATA CAN BE GOTTEN EASILY BY THE APPLICATION.

SHARED MEMORY - BOTH THE ADAPTER AND APPLICATION USE THE SAME MEMORY ADDRESSES IN THE HOST AND DATA IS MOVED THEIR INSTEAD OF USING ADAPTER BUFFERS. IT THEN IS ACCESSIBLE TO THE APPLICATIONS.

DIRECT MEMORY ACCESS (DMA) - A DMA CONTROLLER CHIP IN THE HOST PUTS DATA FROM THE BUS DIRECTLY INTO THE HOST MEMORY BYPASSING THE HOST'S CPU.

BUS MASTERING - INTELLIGENT CARDS CAN TEMPORARILY TAKE OVER CONTROL OF THE BUS AND MOVE DATA VIA DMA TECHNIQUES WITHOUT USING HOST CPU CYCLES.

IBM'S MICRO CHANNEL ARCHITECTURE (MCA) - 16/32 BIT BUS STRUCTURE AND PROTOCOLS WHICH CAN SUPPORT MULTIPLE, SIMULTANEOUS BUS MASTER CARDS.

EXTENDED INDUSTRY STANDARD ARCHITECTURE (EISA) - SIMILAR TO MCA

USING THE PC BUS EFFICIENTLY

Getting data to/from an adapter card to system memory has become an important topic as this is a potential bottle neck point. This can also impact the PC's ability to effectively use a high speed device such as a high speed LAN. A PC's bus passes data in a bit-parallel manner in 8, 16, or 32 bit groups. The larger the group the better; however, the PC's CPU and other components must be able to work with these "word" sizes. The adapter cards must also match the PC's word size or, if smaller, slow down the transfer rate. In addition to bus size, how the bus is used can also greatly effect the transfer rate.

DMA or Direct Memory Access is a technique that utilizes an additional "DMA" chip or controller. This takes care of the transfer of data from an adapter to the PC's main memory so that the PC's main processor chip, or CPU, does not have to. For DMA transfer, the adapter's controller or CPU chip sends a signal to the PC's CPU indicating it needs DMA. The PC's CPU then relinquishes control of the PC bus to the DMA controller. Once the DMA has command of the bus, it begins to take the data from the card and place it directly in memory. It can do this because it has been informed by the CPU of the appropriate memory address at which to begin. When complete, the DMA controller returns bus control to the PC's CPU.

The IBM Micro-Channel based PS/2s include an IBM designed DMA chip, which is up to $2\frac{1}{2}$ times faster than the PC/AT's DMA chip and use either a 16 or 32 (386 machines) bit bus. The 32 bit Micro-Channel slots also contain extra pins needed to support another feature called matched memory cycles, which speeds information even faster. The Micro Channel's interrupt signals, used by adapter cards to get the main CPU's attention when service is required, can be shared among several adapter cards, not just used one at a time as in the PC/AT. Consequently, a greater number of adapter cards can operate simultaneously without interfering with one another.

The Micro Channel also supports other new features such as arbitration, programmable option select, audio signal, and auxiliary video adapter. The arbitration feature supports the DMA function and allows high performance adapters, called masters, to take complete control of the system bus and transfer information without the assistance of the main CPU, a technique that is 2-4 times faster than simple DMA. Through this arbitration capability, up to 15 bus master cards can efficiently share control of the system with the main CPU. The Programmable Option Select feature in the Micro Channel eliminates all mechanical switches on the system board and adapter cards and replaces them with electronic switches.

Extended Industry Standard Architecture or EISA bus is similar to MCA as it also supports high speed, bus mastering capabilities but with different features than the MCA systems. EISA adapters are not compatible with MCA machines. EISA bus supports AT cards.

Bus master cards are more expensive but provide greater performance. Some Ethernet bus master cards can saturate a 10M bps LAN compared to non-bus master cards that can use only 10%-40% of that bandwidth.

EISA VS MCA TECHNICAL SUMMARY

FEATURE	EISA	MCA	AT
Supports existing AT cards	Yes	NO	YES
Open systems architecture	Yes	NO	NO
Max throughput (M bytes/s)	33	20	3.5
Max memory addressing (MB)	4096	4096	16
Current clock speeds (Mhz)	8.33	10	8

DMA SPEEDS

BUS TYPE	DATA PATH WIDTH	DMA CYCLE TIME (sec.)	TRANSFER RATE (MB/s)
PC	8-bit	1.05	1.0
AT	16-bit	1.67	1.2
AT	16-bit	1.25	1.6
MCA	16-bit	.4 - .6	3.0-5.0
MCA			
EISA	32-bit Standard	1.0	4.0
EISA	32-bit Type A	.75	5.3
EISA	32-bit Type B	.50	8.0
EISA	32-bit Type C	.12	33.0

BUS MASTER RATES

BUS TYPE	DATA PATH WIDTH	BUS SPEED (Mhz)	TRANSFER RATE (MB/s)
MCA	8-bit	10	10
MCA	16-bit	10	20
MCA	32-bit	10	40
EISA	8-bit	8	8
EISA	16-bit	8	16
EISA	32-bit	8	33

NIC CONSIDERATIONS

IBM COMPATIBILITY (TOKEN RING CARDS):

Source Routing is one method of routing packets through several LANs connected by bridges. With Source Routing, the bridges do not contain network address tables for forwarding packets as the route is contained in the packet. In contrast, transparent bridges that use the Spanning Tree algorithm maintain a list of the addresses on the two networks they connect. All Token Ring cards support Source Routing; however, IBM's NIC -does- source routing which is integrated onto the card's firmware. Many other cards require some additional software.

DRIVER PERFORMANCE:

The Driver is the software that enables the LAN Network Operating System to run the interface card. Some Driver's, like the IBM Token Ring driver from Texas Instruments (a major Token Ring chip manufacturer) are written in "C" to interface to the IEEE Logical Link Control (LLC) layer - adaptable but not as efficient. Other NIC vendors will write different drivers or rewrite the code in a low level language like assembly language to attain high performance.

ON BOARD SOFTWARE:

Some NIC manufacturers will allow software to be integrated onto the NIC. For example, IBM includes LLC (Logical Link Control) on the adapter while others enable different protocols to be run on the card. This frees up the host memory for additional operations, especially important for computers with limited RAM.

BUS MASTERING:

On an XT or AT machine, bus master cards may not be worth the expense. True bus mastering can't be achieved on these machines as the DMA controller on the motherboard must get the CPU's permission to control the bus, slowing the process and possibly stopping other processing. However, in a high performance system like the PS/2, bus master cards with efficient drivers are recommended. MCA and EISA bus structures enhance the data transfer performance performance.

BUFFER SIZE:

Buffers are temporary storage locations on the I/O card where data is moved to and from between the network and the PC internals, such as PC memory or disks. The more memory on the NIC the more data that can be stored on the card at once, which generally improves the I/O transfer performance. How much is enough depends upon the use of the machine in which the NIC is installed. For example, servers handling multiple I/O requests should have a large buffer, often called "server" versions by NIC manufacturers. Another place where large buffers are a good idea is when PC to mainframe connectivity is a requirement for large data transfers.

SAMPLE TOKEN RING NIC VENDORS

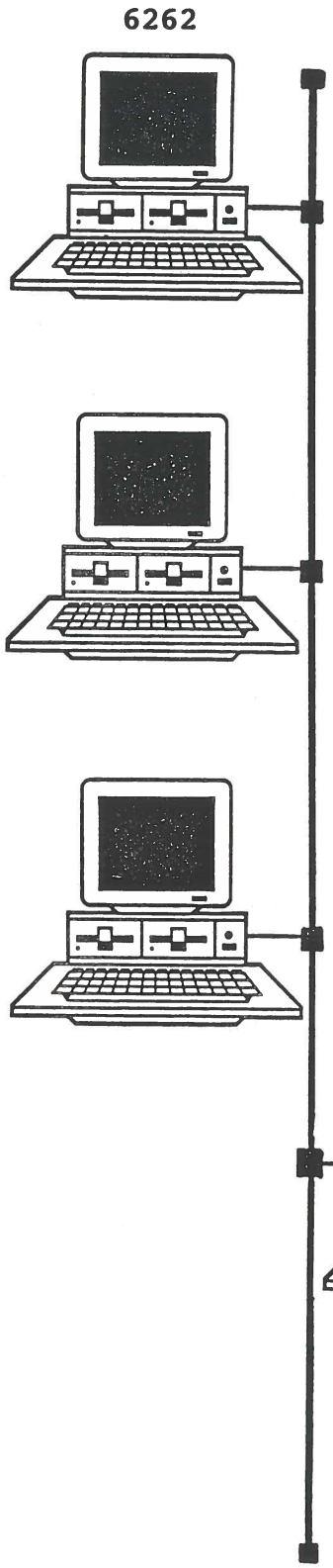
COMPANY	PRODUCT	BOARD MEMORY	BUS SIZE	CABLE	BUS ACCESS	SHARED MEMORY
3COM	Token Link$	256k	8/16	UTP	DMA	-
Gateway Comm.	G/TR AT Adapt.	128k	16	UTP/STP	DMA	-
IBM	IBM TR Network 16/4 Adapter A	64k	16	4M UTP 16M STP	Shared Mem.	16-64k
Madge Networks	Madge MCA Ring Node	3k	16	STP	DMA Bus Master	-
NCR	NCR PC TR	16k	8/16	IBM 1-9	Shared Mem.	8k
Proteon	pl840	18k	16	UTP/STP	DMA Bus Master	-
Ungerman Bass	NIUps/TR	512k	16	STP/UTP Coax Fiber	Shared Mem.	32k
Western Digital	Token Master	128k	16	IBM 1-9	DMA	-

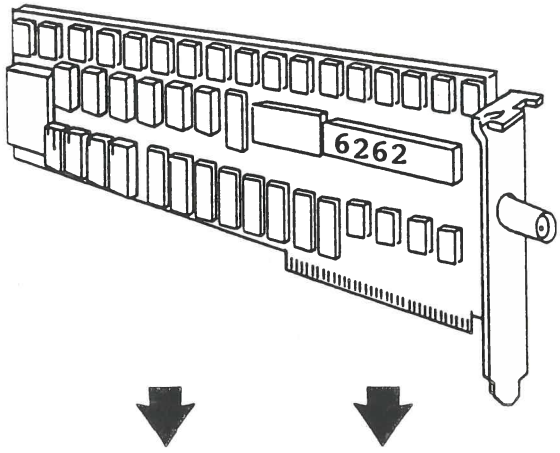
DRIVER SUPPORT TYPES

Novell Netware	3270 Emulation	Banyan Vines	NetBIOS
APPC Term. Emulation	IBM LAN Support Program	3COM 3+/3+Open	Microsoft LAN Manager
OS/2 Based NOS	TCP/IP	IBM PC LAN Manager	Novel Advanced Netware
Ungerman Bass Net/One	DSC Nexos	Apple AppleShare	Apple TokenTalk
DCA 10Net Plus	NCR LAN Manager		

ETHERNET OR TOKEN RING CARDS COST $400 - $700 PER WORKSTATION
WITH SERVER VERSIONS UP TO $1000.00

DEVICE ACCESS/ADDRESSING





Destination	Source	Type	Data	CRC-32

Ethernet V2.0 Packet Format

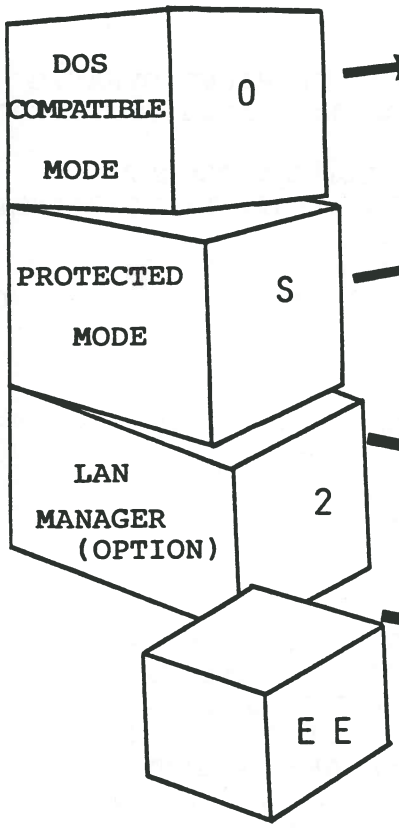
Destination	Source	Length	Data	CRC-32

IEEE 802.3 Packet Format

ADDRESSES ARE SIX 8-BIT BYTES LONG (2 MORE OPTIONAL). EMBEDDED ON THE NIC BY MANUFACTURER WITH THE FIRST THREE BYTES RESERVED FOR THE VENDOR AND NIC MODEL NAME.

USER NETWORK ADMINISTRATORS HAVE THE OPTION OF OVER RIDING THIS ADDRESS WITH THEIR OWN SCHEME, WHICH MAY FACILITATE NETWORK MANAGEMENT. FOR EXAMPLE, ONE CAN RESERVE BLOCKS OF ADDESSES FOR A DEPARTMENT OR MAINFRAME SYSTEM.

THE BUILDING BLOCKS OF OS/2



- ROM BIOS COMPATIBLE WITH DOS3.3
- EMULATION OF NATIVE DOS ENVIRONMENT

- MULTITASKING SUPPORT
- API DESCRIBED BY DYNAMIC LINK LIBRARIES
- OS/2 KERNAL
- DEVICE DRIVERS
- INTERPROCESS COMMUNICATIONS
- VIRTUAL MEMORY AND PERIPHERALS
- PRESENTATION MANAGER

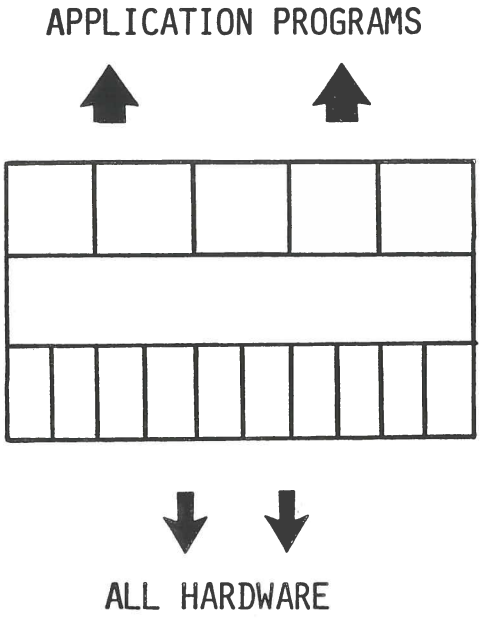
- IBM BASED LAN SERVER. MICROSOFT AND OTHER COMPANIES CREATE THEIR OWN VERSION BASED ON OS/2 STANDARD EDITION ABOVE.

- COMMUNICATIONS MANGER - TERMINAL EMULATIONS, APIs, AND LAN REDIRECTOR
- DATABASE MANAGER - FULL FEATURED RELATIONAL DBMS CONSISTENT WITH IBM'S HOST PRODUCTS DB2 AND SQL. INCLUDES QUERY MANAGER AN UTILITIES.

Multitasking operating systems like OS/2, Unix and other minicomputer and mainframe based types allows the machine to run multiple programs simultaneously. This is not like the crude switching between two independent programs which take turn running. For example, you can be writing text in one program, ask a database program to find items over $100, continue writing and have the parts list show up in the text.

Interprocess communications is the technique that makes these multitasking operating systems powerful. Techniques such as Pipes, Queues, Semaphores, etc. allow the multiple programs running in one machine to communicate with each other by passing data, commands, or even for one program to start and run another. On LANs, this process can be extended across the network, having a program on one machine easily communicate with a program on another machine transparently.

THREE BASIC LAYERS OF OS/2



DLL - DYNAMIC LINK LAYER: PROVIDES DYNAMIC LINK LIBRARIES (DLIBs), APIs TO PROGRAMS.

KERNEL - PROVIDES INTERNAL MANAGEMENT AND ISOLATION FROM APPLICATIONS/HARDWARE

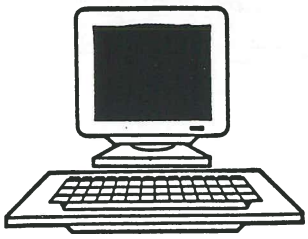
DEVICE DRIVERS - LINK TO HARDWARE, REQUIRE ONE PER EACH TYPE FROM SYSTEM CLOCK TO INTERFACE BOARDS

DYNAMIC LINK LAYER PROVIDES OS/2's APPLICATION PROGRAMING INTERFACE (API). APPLICATIONS USE "NAMED CALLS" INSTEAD OF NUMBERED INTERRUPTS AS IN DOS. DLL IS MADE UP OF SEPARATE DYNAMIC LINK LIBRARIES (DLIBs) WHICH PROVIDE SPECIFIC API SERVICES BUT ARE NOT INEXTRICABLY LINKED TO THE OS - THEY ARE LOADED INTO MEMORY AT RUN TIME OR CAN BE CALLED BY A PROGRAM. OS/2 COMES WITH A NUMBER OF DLIBs FOR KEYBOARD, SCREEN, AND MOUSE BUT THEY WILL BE EXPANDED BY IBM, MICROSOFT, AND OTHER VENDORS. FOR EXAMPLE, A CAD/CAM VENDOR MIGHT CREATE A PRIMITIVE DLIB FOR CAD GRAPHICS TO SPEED PROGRAM PERFORMANCE. AN API CAN BE UPGRADED BY REPLACING THE OLD DLIB WITH A NEW ONE.

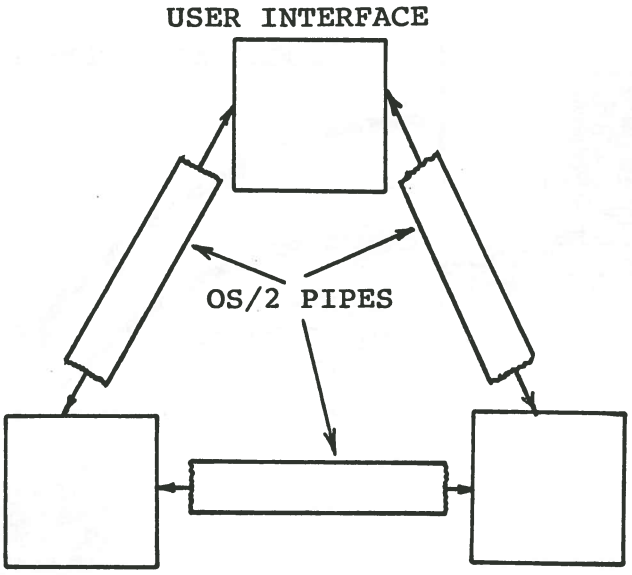
KERNEL IS THE OS/2 NERVE CENTER. IT HANDLES MEMORY MANAGEMENT, TASK SCHEDULING, INTERPROCESS COMMUNICATIONS, FILE I/O CHORES, TIMER SERVICES, ENVIRONMENT MANAGEMENT, BASIC TEXT-MESSAGING FACILITIES, ETC.

DEVICE DRIVERS PROVIDE THE SUPPORT FOR ALL SYSTEM HARDWARE, NO HARDWARE TALKS DIRECTLY TO THE KERNAL. EVERYTHING FROM THE SYSTEM CLOCK TO THE TOKEN RING INTERFACE BOARD MUST BE DESCRIBED BY A DEVICE DRIVER. EACH NEW GRAPHICS BOARD, MEMORY ADD-ON, AND NETWORK CARD WILL REQUIRE A COMPLETE DEVICE DRIVER TO WORK WITH OS/2. EXISTING PRODUCTS WILL NEED NEW ONES AND IN SOME CASES MAY NOT BE ABLE TO MIGRATE TO THE PROTECTED MODE. IN OS/2, PROGRAMS CAN SHARE DEVICE DRIVERS BUT ARE NOT ABLE TO HOG THE DEVICE ITSELF.

OS/2 INTERPROCESS COMMUNICATIONS



STANDALONE PC

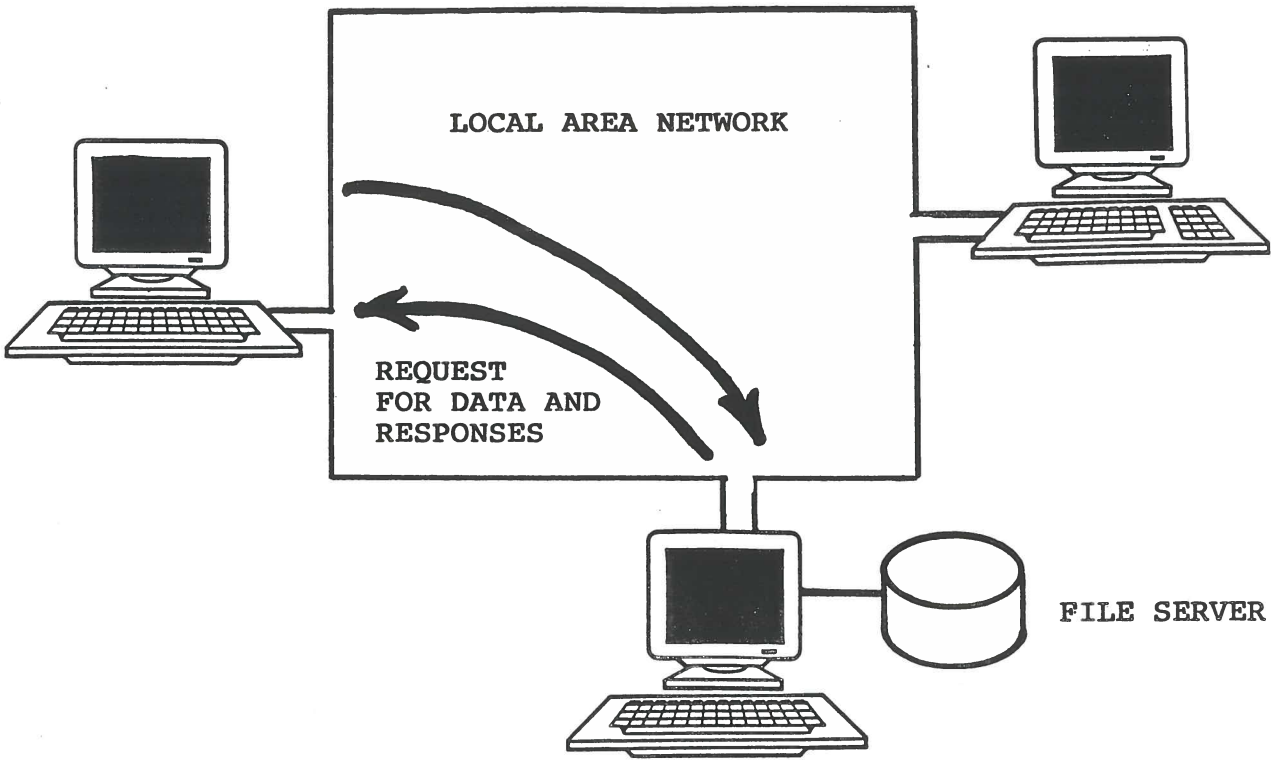


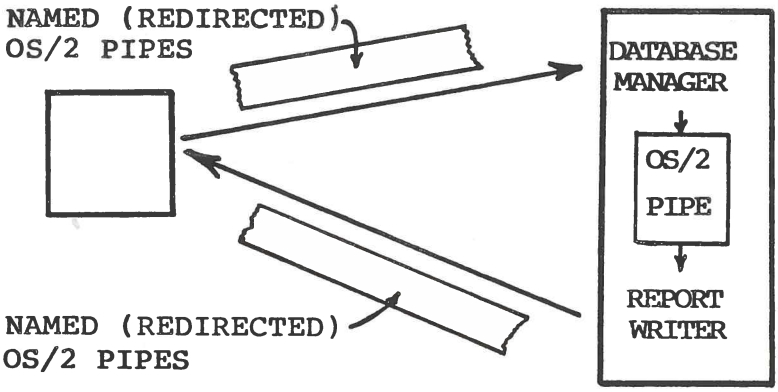
OS/2 HAS THE FACILITIES TO PROVIDE COMMUNICATIONS BETWEEN DIFFERENT PROGRAMS THAT ARE RUNNING SIMULTANEOUSLY IN THE PC. THERE ARE FOUR TECHNIQUES THAT CAN BE USED TO PROVIDE INTERPROCESS COMMUNICATIONS, OR THE PASSING OF DATA BETWEEN THESE INDEPENDENT PROGRAMS: 1) SHARED MEMORY - PROGRAMS USE THE SAME MEMORY SPACE FOR THE DATA. 2) SEMAPHORES - FLAGS ARE USED BY THE PROGRAMS TO SIGNAL EACH OTHER WHEN/WHERE TO USE THE DATA AND TO KEEP THE PROCESSING OF BOTH PROGRAMS SYNCHRONOUS. 3) PIPES - PIPES ARE THE PROCESS OF SERIALLY PASSING DATA BETWEEN PROGRAMS, MUCH LIKE AN INTERNAL COMMUNICATIONS CHANNEL. 4) QUEUES - THIS TECHNIQUE STACKS THE DATA LIKE SEPARATE MESSAGES SO THAT THE RECEIVING PROGRAM CAN SELECT THE DATA IN ANY ORDER.

PRESENTATION MANAGER - THIS IS A GRAPHICAL INTERFACE BASED UPON MICROSOFT WINDOWS, HEAVY MENU USAGE. CERTAIN FEATURES OF THE PRESENTATION MANAGER DO NOT CHANGE NO MATTER WHICH APPLICATIONS RUN WITH IT. THIS STANDARDIZATION MAKES IT EASIER FOR APPLICATION DEVELOPERS TO WRITE EASY-TO-USE AND CONSISTANT INTERFACES. THE WINDOW CAPABILITY SUPPORTS MULTIPLE COMMUNICATIONS, OR SESSIONS, IN A PEER-TO-PEER MODE.

DOS 3.3 COMPATIBILITY - APPLICATION WRITTEN UNDER DOS 3.3 ARE SUPPORTED EXCEPT THOSE THAT ARE TIME-DEPENDENT OR HARDWARE SPECIFIC SUCH AS COMMUNICATIONS PROGRAMS, DEVICE DRIVERS, SOME SPREADSHEETS, AND NETWORK DEPENDENT APPLICATIONS. THESE TYPES ATTEMPT TO BY-PASS THE OPERATING SYSTEM, WHICH OS/2 DOES NOT ALLOW.

OS/2 PIPES VS MICROSOFT'S NAMED PIPES





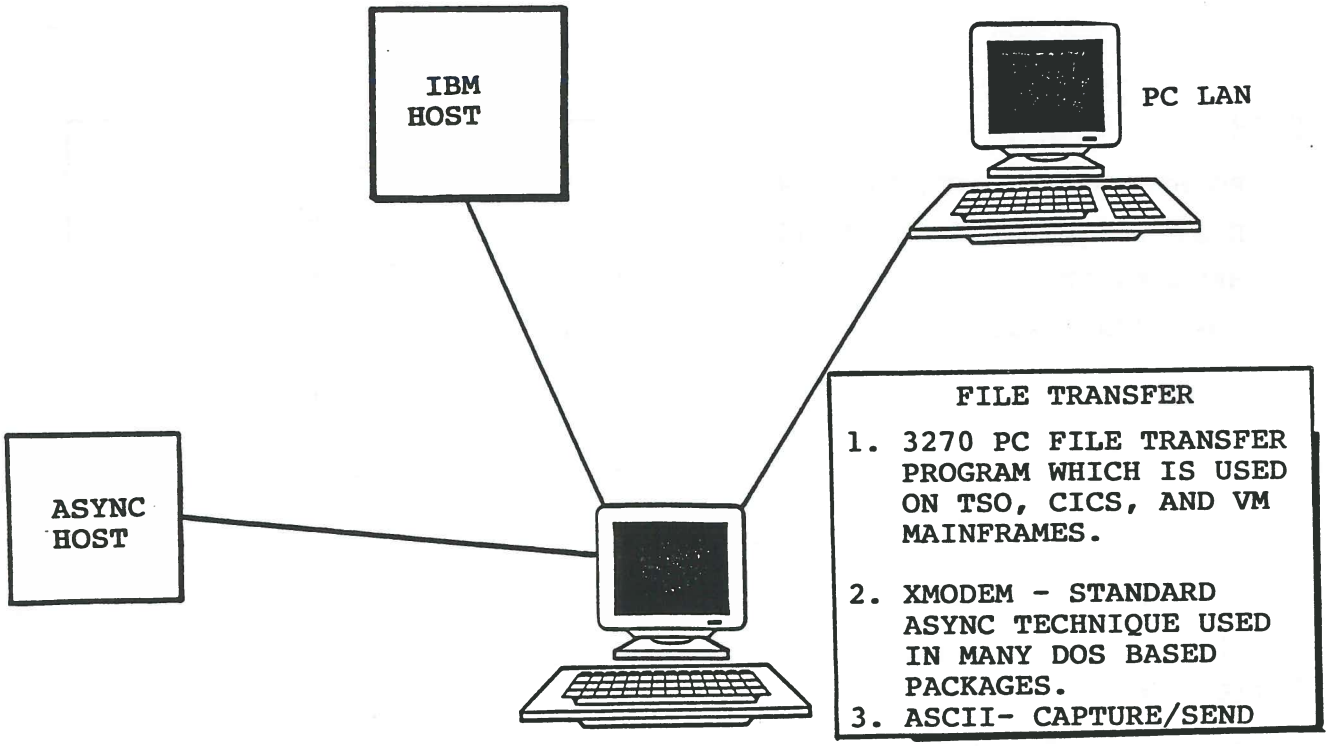
LAN MANAGER IS EASIER FOR APPLICATIONS TO USE THAN NETBIOS.

INTERPROCESS COMMUNICATION OF OS/2 IS REDIRECTED OVER THE NETWORK = NAMED PIPES.

IN THE OS/2 BASED SERVER, APPLICATIONS USE THE IPC TO PASS INFORMATION.

THE EXISTING GENERATION OF PC NETWORKING SOFTWARE STANDARDS GREW OUT OF MICROSOFT'S AND IBM'S SEPTEMBER 1984 ANNOUNCEMENTS OF DOS3.1, MS-NET, AND THE IBM PC LAN PROGRAM. THE ORIGINAL PC LAN PROGRAM CONTAINED THE NETBIOS SOFTWARE INTERFACE, WITH LATER VERSIONS FOR THE TOKEN RING NETWORK. THIS PROVIDES THE INTERFACE TO THE NETWORK HARDWARE ADAPTERS SUCH AS THE TOKEN RING ADAPTER, AND THE APPLICATION PROGRAMS THAT WISH TO COMMUNICATE ON OR HAVE ACCESS TO THE LAN. THE IMPORTANT STANDARDS FROM THESE PRODUCTS WERE DOS 3.1 FILE AND BYTE-STREAM LOCKING CONVENTIONS AND THE NETBIOS SESSION/TRANSPORT LEVEL INTERFACE. VIRTUALLY EVERY SIGNIFICANT PC NETWORKING PRODUCT SUPPORTS THESE STANDARDS. THESE STANDARDS ALLOW NETWORKED PCs TO RUN APPLICATIONS DESIGNED TO RUN ON STANDALONE PCs: USERS CAN SHARE FILES OR COMMON DEVICES LIKE PRINTERS. HOWEVER, DOS WAS LIMITED IN RAM AND SUPPORTS ONLY SINGLE TASKING. NETBIOS, BEING A LOW LEVEL INTERFACE, WAS A DIFFICULT INTERFACE FOR APPLICATION DEVELOPERS.

OS/2 EXTENDED EDITION - COMMUNICATIONS MANAGER



TERMINAL EMULATIONS:	3178, 3278, 3279, 3101, DEC VT 100
PHYSICAL LINKS:	SDLC, DFT (DISTRIBUTED FUNCTION TERMINAL), X.21, TOKEN RING, ASYNCHRONOUS
PROTOCOLS:	LU6.2, 3270 DATA STREAM, ASYNCHRONOUS, X.25 CONCURRENTLY! (3270 MODE SUPPORTS 10 SESSIONS ON SDLC LINKS OR 5 SESSIONS ON TOKEN RING)
APPLICATION PROGRAMMING INTERFACES (API)	APPC, SERVER/REQUESTER INTERFACE FOR ENHANCED CONNECTIVITY FACILITY (SRPI/ECF), ASYNCHRONOUS COMMUNICATIONS DRIVER INTERFACE (ACDI), NETBIOS
LAN HARDWARE:	IBM PC NETWORK, IBM TOKEN RING (IBM VERSION), SUPPORTING NETBIOS, APPC, AND 802.2 INTERFACES. NOW ETHERNET

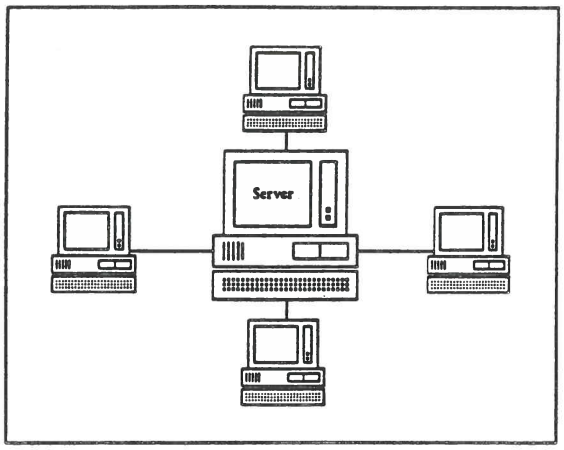
FOR PC LAN, COMMUNICATIONS MANAGER ONLY SUPPORTS A WORKSTATION REDIRECTOR AND CAN NOT ACT AS A SERVER. THE SERVER FUNCTION NEEDS EITHER MICROSOFT'S LAN MANAGER OR IBM'S LAN SERVER SOFTWARE (WHICH IS BASED ON LAN MANAGER) WHICH USE OS/2 ON THE SERVER MACHINE.

NETBIOS, ORIGINALLY PART OF IBM'S PC LAN PROGRAM, IS AN API THAT PROVIDES FACILITIES FOR INTERPROCESS COMMUNICATIONS AND SUPPORTS LAN DISTRIBUTED APPLICATIONS. APPC SUPPORTS MAINFRAME DISTRIBUTED APPLICATIONS.

LAN TOPOLOGY

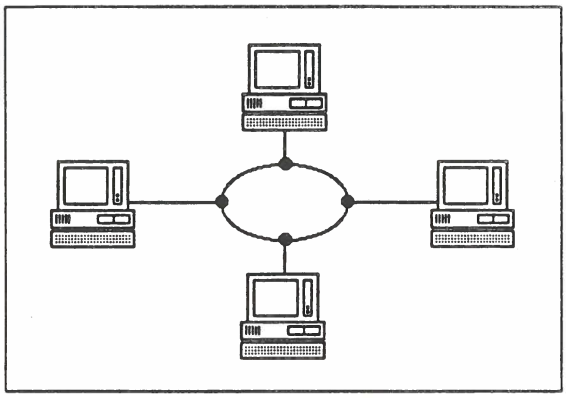
STAR

- POINT-TO-POINT CONNECTIONS
- EASY TO ADAPT TO BUILDING
- MANAGEABLE
- PORT CONSTRAINED



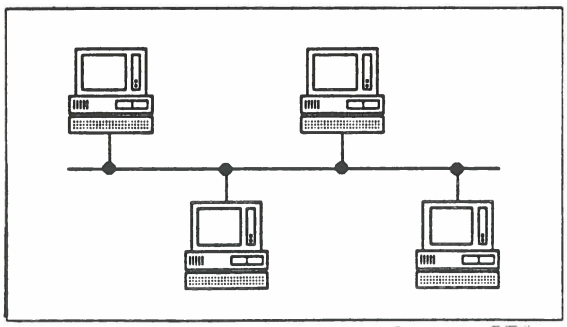
RING/LOOP

- DISTRIBUTED CONTROL
- ALL DEVICES MUST BE UP
- LIMITED FLEXIBILITY
- SUPPORTS SIMPLE PROTOCOL
- DISTANCE SENSITIVE



BUS

- OPEN ENDED
- FLEXIBLE GEOGRAPHIC SETUP
- SOME DAMAGE CONTROL
- GOOD FOR FACTORIES



LAN ACCESS METHODS

ACCESS METHOD is the term given to the set of rules by which networks arbitrate their use, share the network with many devices. It works on the physical layer of the communications architecture as it concerns the use of the cable. The access method doesn't care what is being sent over the network only how it is sent.

There are three major access methods in use today, though many more exist. They are Ethernet, Arcnet, and Token Ring. Actually, these are wide ranging standards that use particular access methods and define other features such as the electrical characteristics of the signal, the size of the data packets sent, etc.

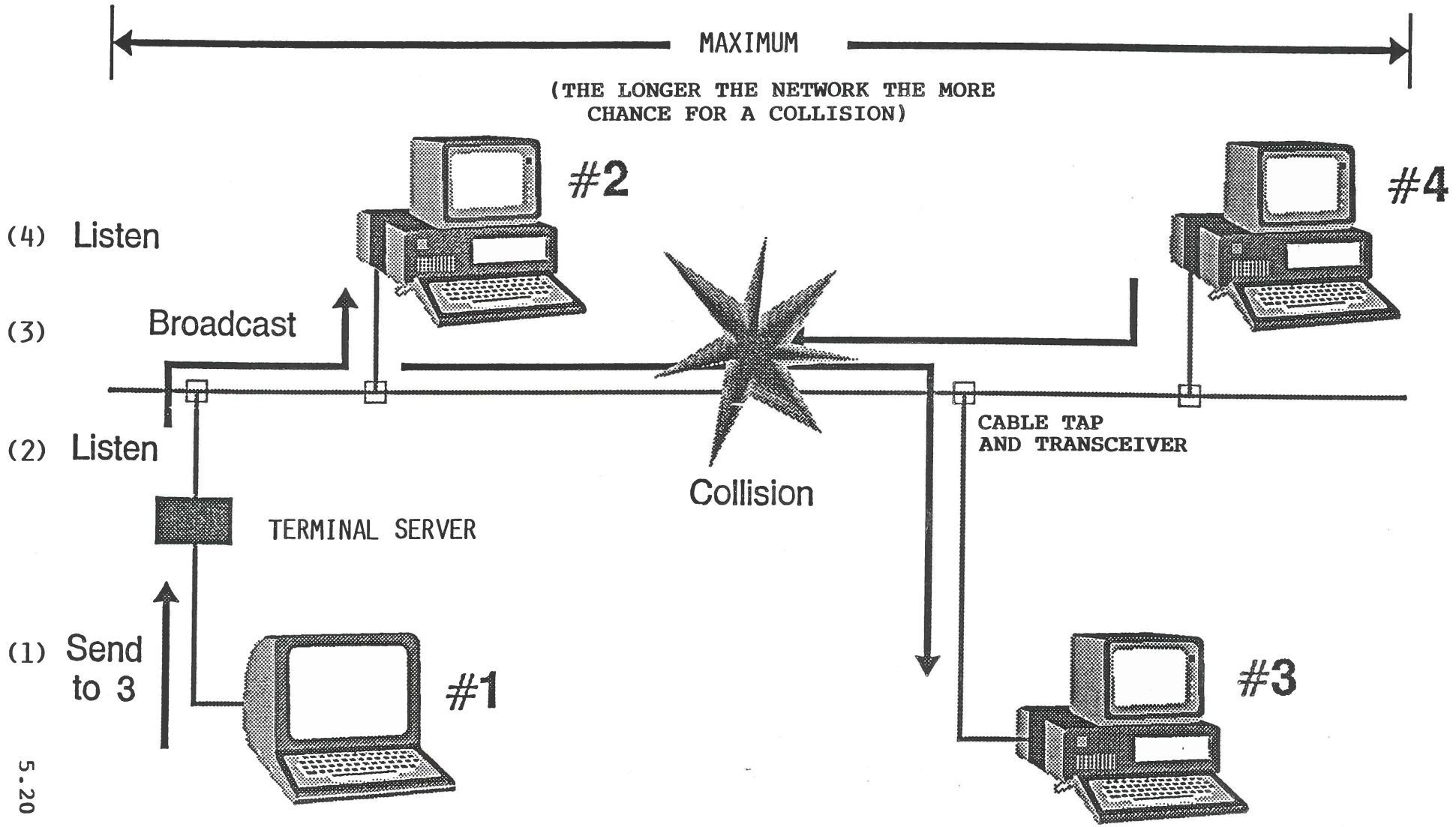
ETHERNET is the most common and was developed by Xerox in the mid-1970s. It was made a standard by Xerox, Intel, and Digital Equipment Corp. (DEC). It uses Carrier Sense Multiple Access with Collision Detection (CSMA/CD) as the specific access method technique. A network device, the interface card, broadcasts a message onto the cable when no one else is using it. The transmitting device listens after sending the message to determine if it collided with another message. If it did then another attempt is made again to broadcast when no one else is using the cable. Broadcast means that the message is sent in all directions and places on the network so every device will hear it. The message is recognized by the proper receiver as the message also includes its address in one of several control fields.

ARCNET was developed by Datapoint Corporation in the early 1970s and is next in installed based after Ethernet. Arcnet is a TOKEN PASSING access method that works on a star-bus topology. That means the network cable is laid out in a series of stars, with each network device connected to a hub at the center of the star with the hubs connected on a bus cable. Hubs can connect 4, 8, 16, or 32 devices. When a device wants to send it must have the "token". The token is a special series of data bits which moves around the network in a given pattern, a logical ring, by being broadcast onto the bus from one device to another by means of an added address. Each device always broadcast to the same address in the pattern. To send a message to a particular device, its address is added to the data along with the pattern-address of the next device to receive the transmission. Ultimately the message goes around the pattern until it reaches the destination.

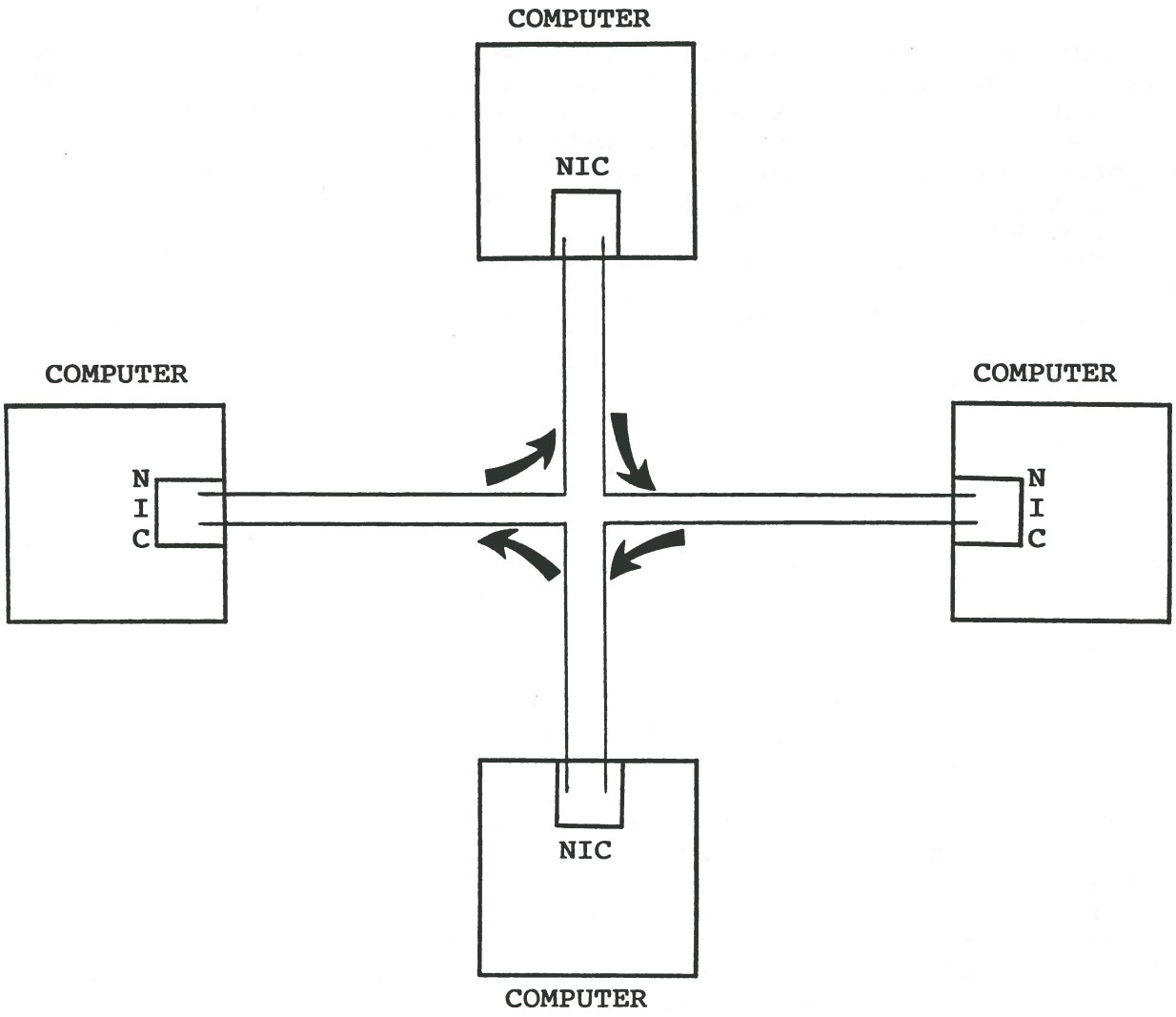
TOKEN RING uses the token passing technique but on a physical ring. Transmissions go one way around the ring into the interface card and back out. Each device along the ring actually reads the token, regenerates it, and forwards it on to the next physical device on the network. When a device wants to send a message it must wait until the token comes around, it marks it busy and appends the data plus destination address before placing the message on the cable. The message/token packet then is passed around to the destination device which marks it received and sends it back out to the sending device, keeping a copy of the data for itself. The sending device now knows it was delivered.

CSMA/CD

CARRIER SENSE MULTIPLE ACCESS WITH COLLISION DECTECTION



SIGNAL FLOW IN THE TOKEN RING NETWORK



IN THE IBM TOKEN RING NETWORK THE SIGNALS, WHICH INCLUDE END USER DATA PACKETS, TOKENS, AND NETWORK CONTROL/MANAGEMENT PACKETS, FLOW ONE WAY AROUND THE NETWORK. THE NETWORK INTERFACE CARDS ARE AN ACTIVE PART OF THE RING ITSELF AS THEY MUST READ AND FORWARD EACH BIT THAT ENTERS THEM. SIGNALS FLOWING ON THE RING MUST GO IN AND OUT OF EACH NIC ATTACHED TO THE RING. IN THIS WAY ALL DEVICES HEAR ALL MESSAGES AND ARE ABLE TO RECEIVE TRANSMISSIONS SENT TO IT BY ANY OTHER DEVICE ON THE RING. DATA PACKETS CONTAIN AN ADDRESS FIELD WHICH IDENTIFIES THE DESTINATION DEVICE ADDRESS AS WELL AS THE ORIGIN DEVICE ADDRESS.

IBM TOKEN RING PROTOCOL

The IBM Token Ring system, also known as the ANSI/IEEE 802.5 standard, got a late start relative to other LAN standards. IBM released it in late 1985, years after Ethernet and ARCnet. It will become the dominant LAN standard. Nodes are the PCs, other computers and other hardware which are electrically connected to one another in a ring configuration. Wires of the ring cable go into the Network Interface Card (NIC) and back out again, thereby including the NIC in the physical ring configuration. As data flows on the ring it must flow through the NIC. A token is a three special bytes of data that is used to provide equal access to the ring network for all nodes. Data flows around the ring in one direction.

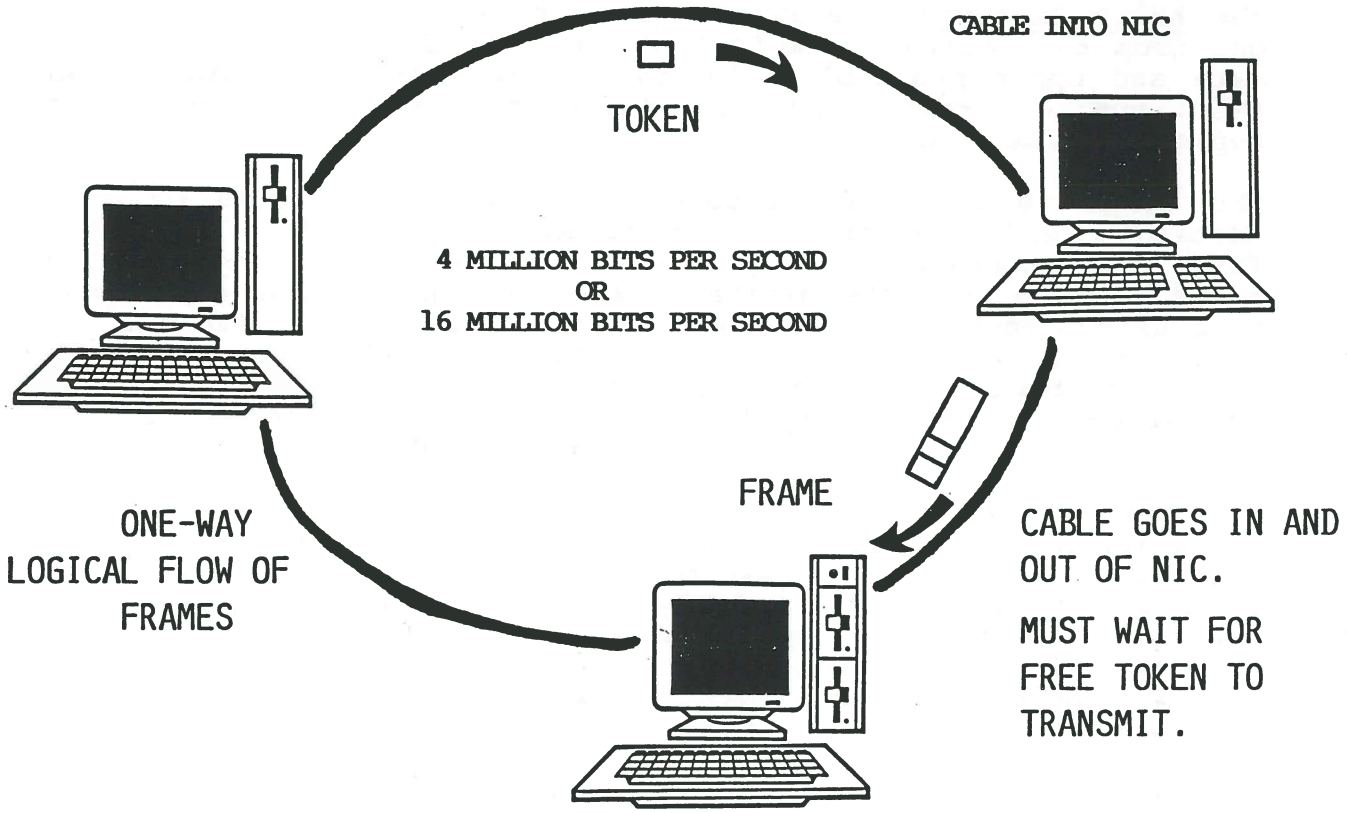
Each node receives information from its nearest active up stream neighbor (NAUN for short) and transmits it immediately downstream, or to the next node on the ring. Unless a node is transmitting its own data, it passes on whatever information it receives from its NAUN verbatim. Thus, any node can transmit information to any other node by sending it through some or all of the others. To keep an orderly process and allow every node to have an equal chance at transmitting, the token is used.

A token provides order in a manner that resembles passing an electronic baton around the ring, whereby we get the term token pasing. A token is a short, 24-bit message that traverses the ring being passed from node to node. Nodes that do not wish to transmit simply pass on the token. Nodes that have been waiting to transmit can only do so when the token arrives at the node. To transmit, the node receives a free token, marks it busy by changing a bit-field, appends its data frame and transmits this package onto the ring. The data frame contains user data, protocol information, to and from addressing information and a frame status field. All recipients of this package, except the destination node, recognize the "busy" status of the token and passes the entire package back out onto the network to its downstream neighbor. Only one transmission like this can occur on the ring at a time.

When the frame reaches the destination node three things happens. First, the node immediately passes all the received information back out to the network. Second, it recognizes its address in the destination field and copies, not removes, the information from the frame and passes it into its computer. Third, it marks the frame status field "received" as it goes by, on back out to the network. Eventually, this packages returns to the transmitting node where three things occur. First, the frame field is stripped off. Second, the status field is recognized as received. Third, the token is changed back to "free" and sent on out to the ring to be used by another node which may be waiting to transmit. A node only get one chance at a time to use the free token and must wait for another turn to send more frames.

The 4M bps (million bits per second) Token Ring version allows only one transmission at a time on the network. However, the 16M bps version can support two transmissions simultaneously to take advantage of the greater capacity.

TOKEN RING LAN



TOKEN FORMAT

3 OCTETS = 24 BITS

START DELIMITER	ACCESS CONTROL	END DELIMITER
VVØVVØØØ	PPPTMRRR	VVlVVlIE

OCTET = 8 BITS

V = SIGNAL VIOLATION
P = PRIORITY MODE
E = ERROR DETECT
I = INTERMEDIATE FRAME
T = TOKEN BIT (1/Ø)
M= MONITOR BIT (1/Ø)
R = PRIORITY RESERVATION

IEEE 802.5 FRAME FORMAT

SD	AC	FC	DESTIN. ADDRESS	SOURCE ADDRESS	RI	USER INFORMATION OR MAC LAYER COMMANDS	FCS	ED	FS

SD = START DELIMITER
ED = END DELIMITER
AC = ACCESS CONTROL
FC = FRAME CONTROL
FS = FRAME STATUS
DESTINATION ADDRESS(6 BYTES)
SOURCE ADDRESS (6 BYTES)
RI = ROUTE INFORMATION (IBM SOURCE ROUTING)
INFORMATION (USER/PROTOCOL)
FCS = FRAME CHECK SEQUENCE (ERROR CONTROL)

TOKEN RING FRAME FORMAT

The Token Ring uses three frame types: the Token, the Frame, and the Abort Sequence. The Frame can be viewed as two frame types: one from the Logical Link Control layer (LLC) which carries user data and upper protocol layer information and the Media Access (MAC) control frame which provides ring management functions on top of the LLC frame.

The Token is a 24-bit sequence divided into 3 bytes or more precisely called octets. The first octet is the Start Delimiter (SD) which contains both viable Ø bits and violations to the rules used to form the digital pulses, called Manchester Coding. This unique combination of specific good and specific bad bits in a certain sequence makes the SD a very unique field and one that means the beginning of a Token or a Frame. The third octet is called the End Delimiter (ED) which contains viable 1 bits and violation bits to represent the end of the Token or Frame.

The second octet in the Token carries all the working information. The first three bits are used to set the Priority of the Token. Each node is assigned a priority for its transmissions from ØØØ (lowest) to 111 (highest). In order for a node to transmit its priority must be equal to or greater than the token's. The last three bits is used by the node to request reservation of the next Token as a transmission passes by the node's NIC.

The fourth bit or Token (T) bit is used to designate the that this is a Token (T=Ø) or a Frame (T=1). The fifth bit is called the Monitor (M) bit which is used for network Token control. It prevents high priority Tokens or Frames from continuously circulating around the ring. It is set to a Ø by the transmitting node and set to 1 by the Active Monitor Node (a designated NIC which performs some management duties). If the Monitor receives an incoming priority Token or frame with M=1, then it knows that the transmitting node did not remove it after a round trip. The Monitor Node then purges it and issues a new Token.

The Abort Sequence is the SD and ED octets together and is issued by a node to denote a transmission problem.

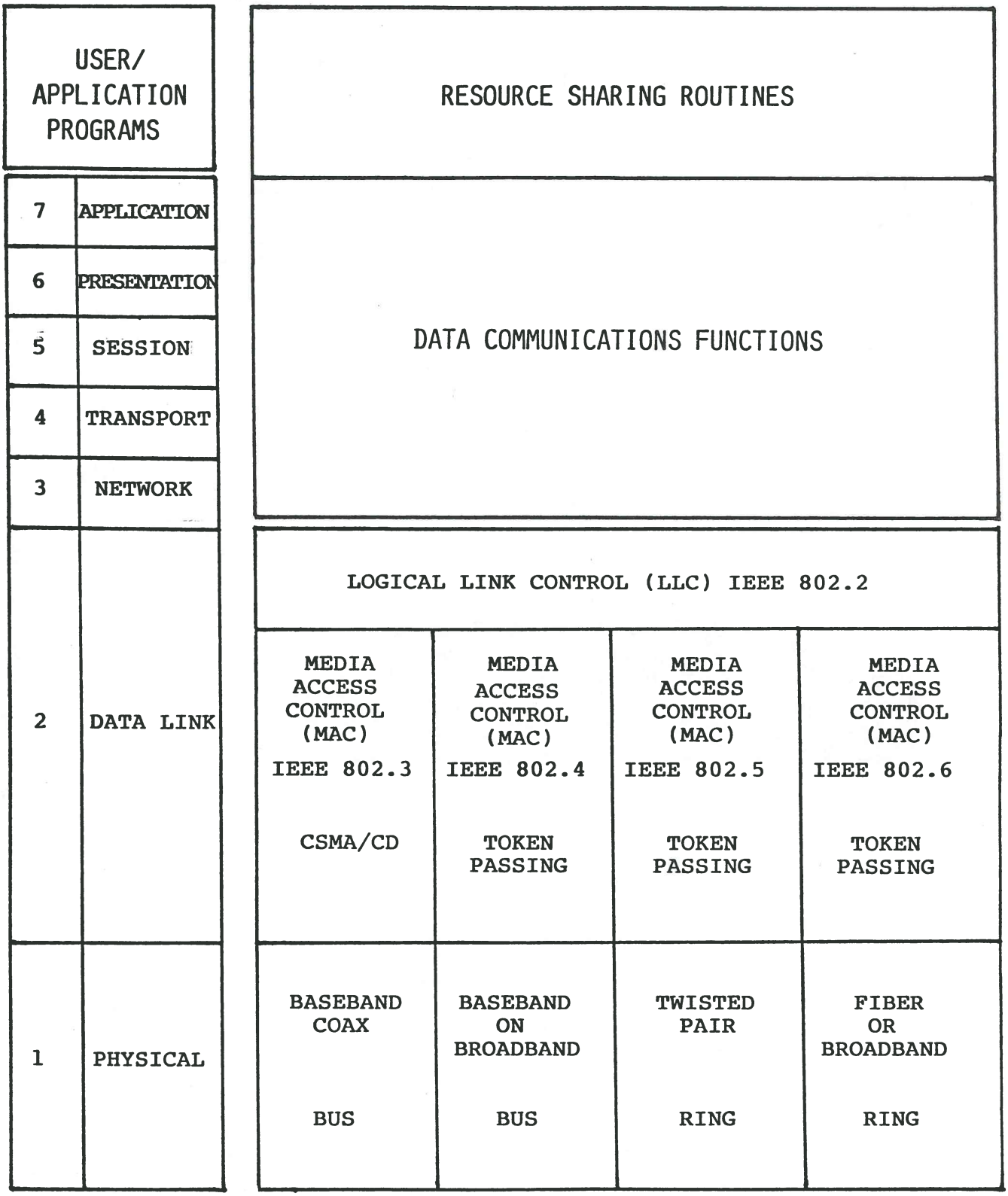
The Frame format may be a MAC frame format carrying network administration information or a MAC/LLC format carrying user data. The MAC format includes the Start Delimiter field and an Access Control field which are taken from the Token format and used to denote Frame beginning. Also in the front is the Frame Control field which contains frame handling information plus the six byte Destination Address field and the Source Address field. The LLC information is in the middle. There are three more MAC fields at the back: First the Frame Check Sum (FCS) used for error checking. Second is the ED from the Token. Third is the Frame Status octet which is used to carry information back to the transmitting node decribing whether the frame was received and copied.

The Route Information field which is also part of the MAC frame is used when a frame traverses multiple rings via bridges.

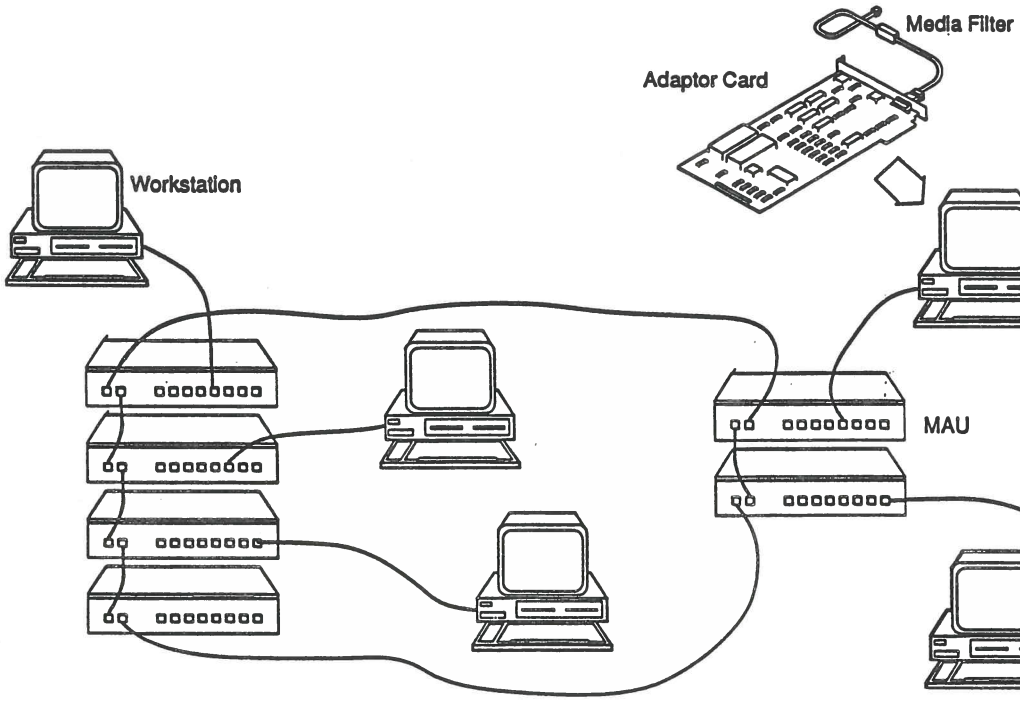
SECTION 6.0

COMMON NETWORK STRUCTURES

DATA COMMUNICATIONS STANDARDS/FUNCTION ORGANIZATION



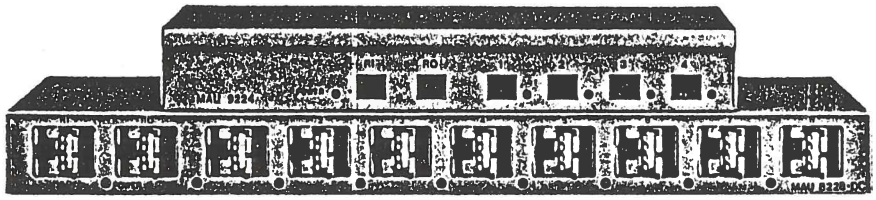
TOKEN RING CONFIGURATION



MAU = MULTI STATION ACCESS UNIT.

WIRING CONCENTRATOR.

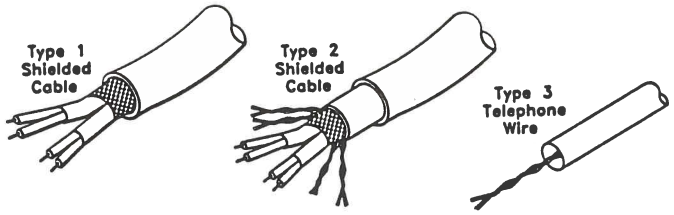
TELECOM CLOSET

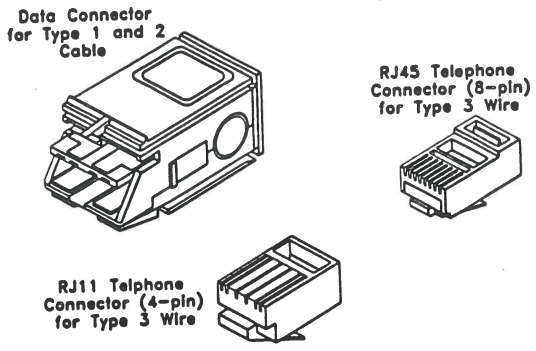


1st, 2nd, 3rd, 4th GENERATION MAU

TYPE 1 WIRE (STP)

TYPE 3 WIRE (UTP)





HERMAPHRODITIC CONNECTOR = GENDERLESS

MEDIA FILTER REQUIRED WITH UTP TO MEET FCC STANDARDS FOR RFI

TOKEN RING PHYSICAL COMPONENTS

Token Ring networks are not wired in a physical ring but rather use a STAR shaped topology, where devices all connect to a central location. Each network node uses a single two-pair cable to connect to a device called a wiring concentrator, known as a MULTISTATION ACCESS UNIT. One pair is for receiving and one pair for transmitting data. The star-shaped wiring topology has some advantages. First, only one cable is needed from each station on the network to a single, centralized location. Buildings are designed to support such wire runs as raceways, risers and other conduit systems are built into the horizontal and perpendicular building structures, initially to support telephone systems or even electrical distribution systems. The second advantage is that it's easy to bypass an inactive or malfunctioning node at the MAU by rearranging the connections at that point.

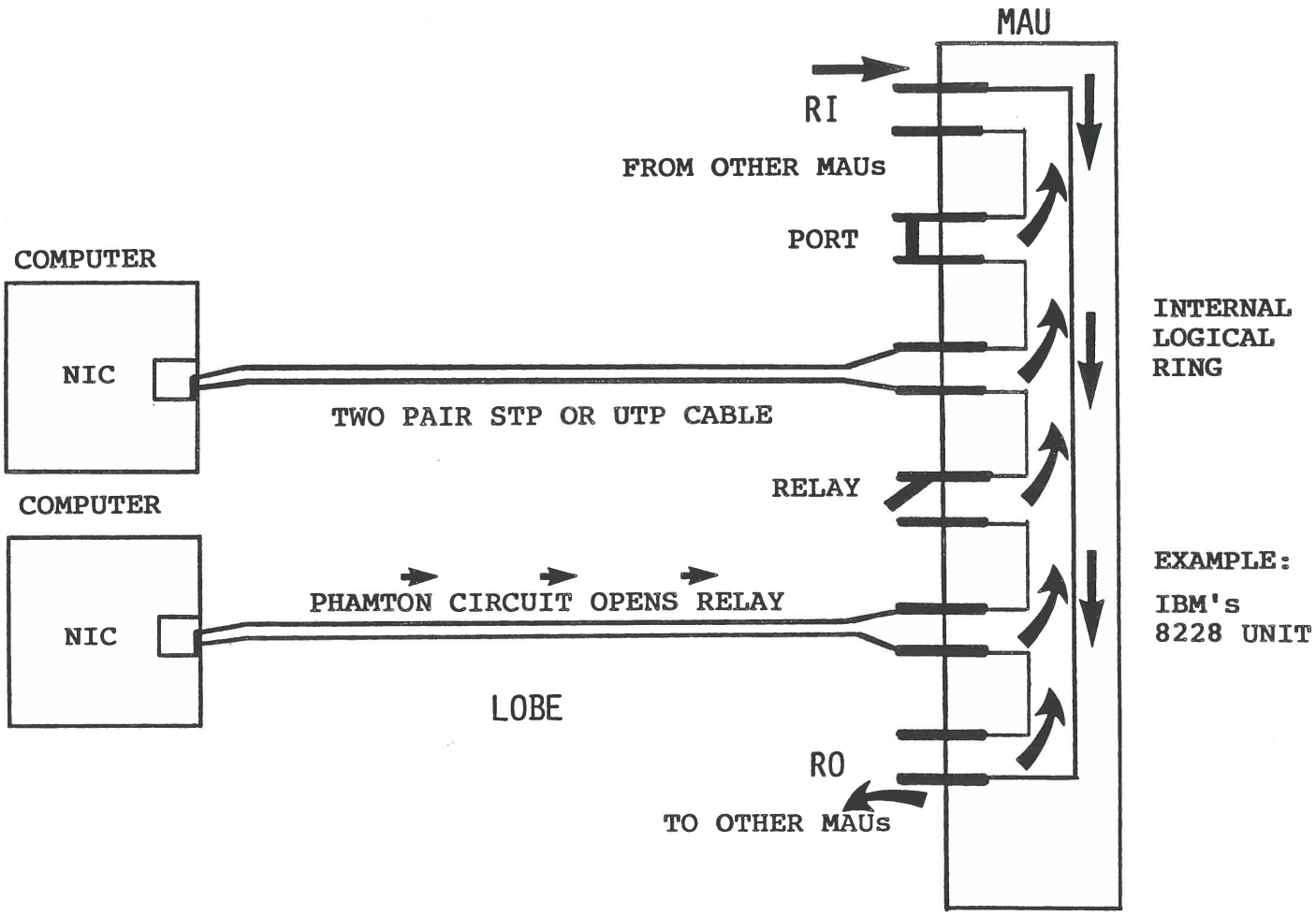
In addition to the wire and MAU, there is a phantom circuit operating. Each active NIC in the nodes on the network sends a low electrical current continuously over the link to the MAU port. A relay in the MAU port opens when it senses this current, thereby letting the node into the ring. Should a malfunction occur, such as a broken cable or bad NIC, the phantom current is lost causing the relay to automatically close off that node from the ring.

Each node attaches to the network using a DB-9 connector on the NIC which is attached to a four-conductor cable which has a hermaphroditic connector on the other end. A similar connector is found in the wall plates, in the MAU ports and on both ends of jumper cables. The hermaphroditic connector can mate directly with identical connectors. When a connector is unplugged, shorting bars inside join the send circuit to the receive circuit, allowing the attached devices to perform loopback tests on itself and the cable. The connections between the node and the ring are transformer-coupled. This limits common-mode voltages and breaks ground loops that could cause harmful interference on the ring.

IBM uses a cable system for LANs that is made up of different types of cable construction. The original, Type 1 cable, was designed for use in the LAN structure described; however, it is an expensive cable comprised of thick, shielded wires and is often referred to as Shielded Twisted Pair (STP). IBM later came out with a Type 3 cable, which uses thinner, Unshielded Twisted Pair (UTP) similar to what other vendors were using. UTP cable is less expensive and somewhat easier to install but requires different connectors, the RJ-45 jack and plugs.

Media Filters are required when using UTP cable with the standard 4 or 16M bps token ring NICs to prevent high frequencies from being radiated from the cable. The FCC has a 30M hz RF limit which can be achieved by signal harmonics in these systems. Media filters also convert the signal to one that is compatible over UTP cable, like a BALUN. A typical media filter would have a cable and DB-9 connector on one end and an RJ-45 plug and UTP cable on the other. Some NICs come with on-board media filters and an RJ-45 jack which would then only require a UTP cable with an RJ-45 plug connection.

MULTISTATION ACCESS UNIT ATTACHMENT



1st GENERATION MAU - UNPOWERED BUT LIMITED LOBE DISTANCE.

2nd GENERATION MAU - EXTERNAL POWER USED TO TRIP RELAY ALLOWING FOR LONGER LOBE LENGTH.

3rd GENERATION MAU - POWERED WITH REPEATERS AT EACH PORT WHICH FURTHER EXTENDS LOBE LENGTH.

4th GENERATION MAU - USE OF ADVANCED DIGITAL SIGNAL PROCESSING TECHNIQUES IN MAU AND NIC WILL, EVENTUALLY, ALLOW 100 Mbps OVER UTP CABLE.

MAU prices range from $500 to $1000 for an 8-port unit depending upon features and wire type used.

TOKEN RING NETWORK CONFIGURATIONS

Typical MAUs have ten ports which are used to connect up to eigth nodes. A single MAU network forms a ring within the MAU and with the connected nodes' NICs. The link from the node to the MAU is called the lobe. Networks larger than eight nodes require additional MAUs. MAUs can be connected using the last two ports, called the Ring In (RI) and the Ring Out (RO) ports, which denote the input to the MAU and the output from the MAU. Jumper cables are used to connect the RO of one MAU to the RI of another local MAU. This assumes that all MAUs are located in the same spot, telephone closet or satellite closet. MAUs can be located in other parts of the building or even in other buildings; however, there are always distance limitations to take into consideration.

Distance limitations for the lobe vary by vendor equipment, the number of MAUs, the distance between MAUs, the wire type used, and the transmission speed. Remember, signals must travel over wire, through connectors and jumper cables and through MAUs, all of which reduce the signal strength. The distance between MAUs can be extended by the use of pairs of repeaters, which are like amplifiers. STP, type 1, cable generally supports longer distances than UTP, type 3 cable while the use of fiber allows for longer distances between MAUs. Also, a 4M bps signal can travel over longer distances than 16M bps signals given the same wire type.

Once the 802.5 standard became widely used the MAU offered non-IBM vendors the opportunity to enhance the network while still being compatible. The "first generation" MAUs, like IBM's 8228, utilize the insertion voltage as power to switch the latching relay in the MAU port. This allowed for flexibility in locating MAUs as no power was required but limited the lobe distance. The 8228 MAU is rated for operation over type 3, UTP, cable for a distance of 100 meters (330 feet) when the ring is contained within a single wiring closet.

"Second generation" MAUs require external power which is used to trip the port relay which results in extending the lobe distances. These units can support lobe lengths of 155 meters (500 feet +) over type 3, UTP cable. Both the first and second generation MAUs are passive devices and do not interact with the data signal.

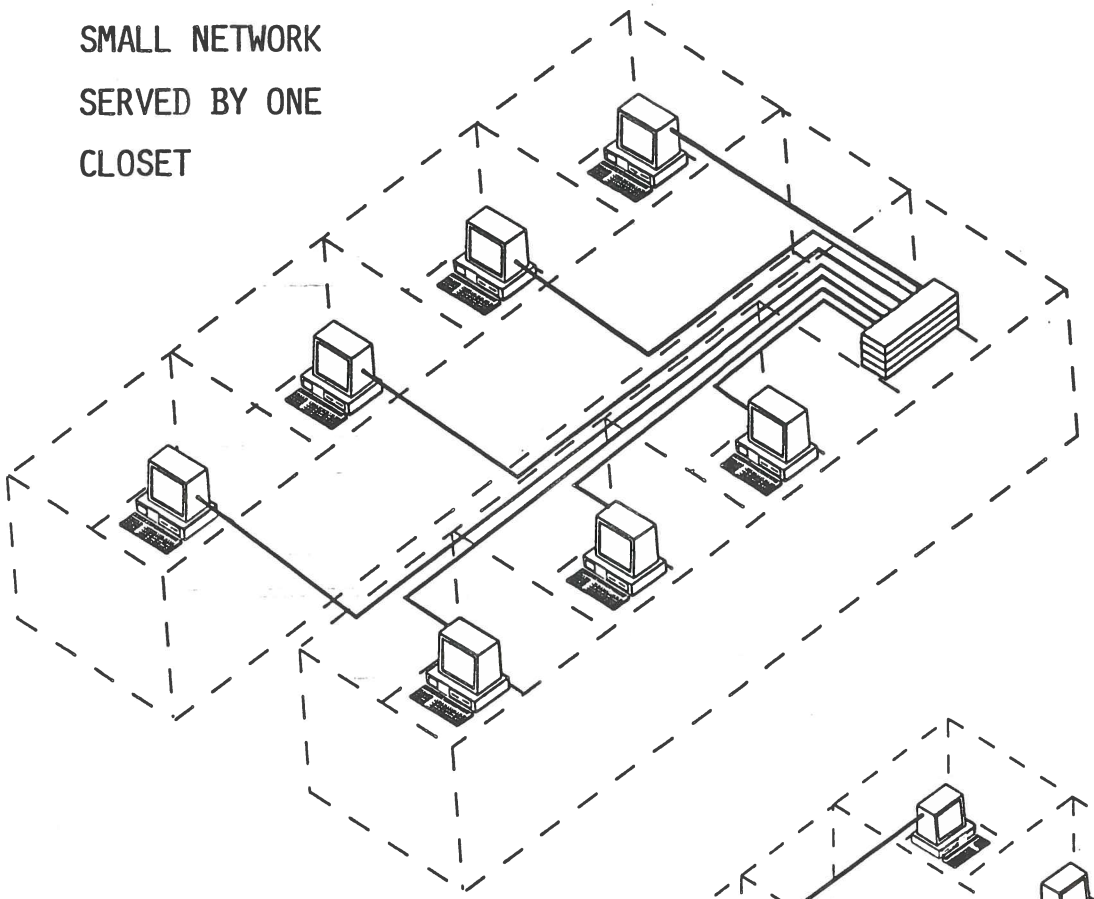
"Third generation" MAUs are active devices in that they regenerate or amplify the signal. In these units, the data only has to travel to the MAU before regeneration, not travel back to the NIC for regeneration, resulting in a much longer data path. These MAUs are rated for 305 meters (1000 feet +) over type 3, UTP cable.

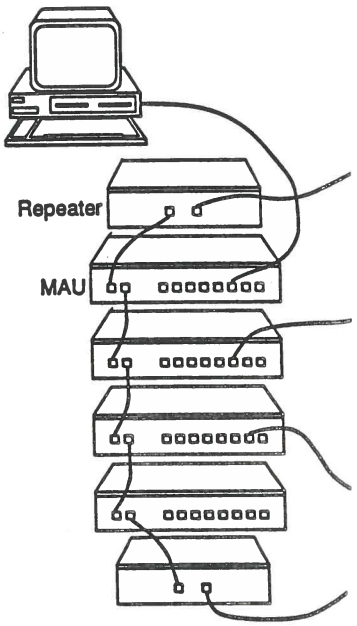
These distances apply to 4M bps systems and generally get cut in half at 16M bps.

"Fouth generation" MAUs are now coming to market, Proteon has announced such a product. These use digital signal processing (DSP) with speeds of 100M bps over UTP demonstated.

TOKEN RING NETWORK LAYOUT

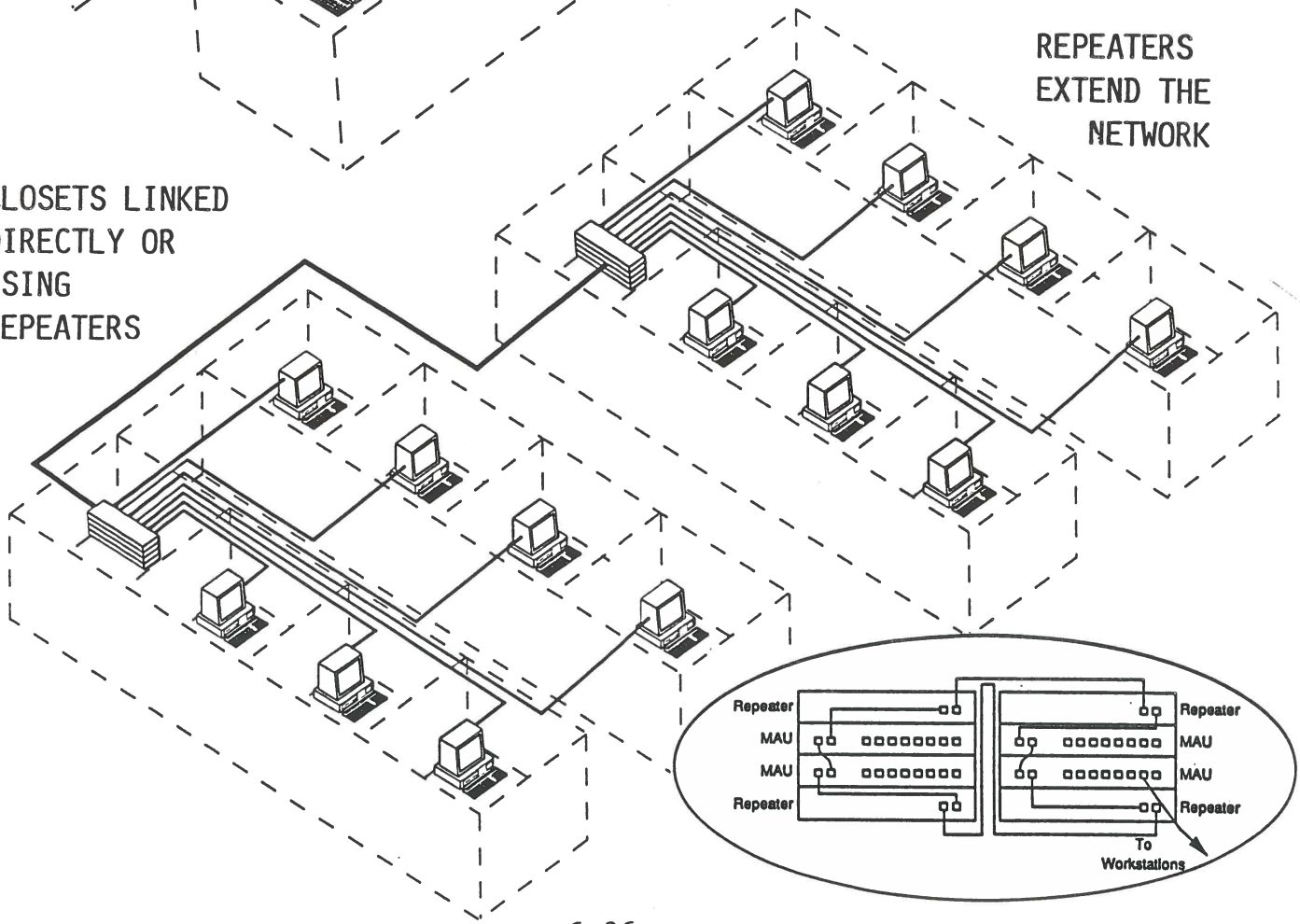
SMALL NETWORK SERVED BY ONE CLOSET





REPEATERS EXTEND THE NETWORK

CLOSETS LINKED DIRECTLY OR USING REPEATERS



TOKEN RING LOGICAL OPERATION

A node attaches to the ring through several steps after the node issues an OPEN command to the network:

1. Lobe Media Check is a verification of the lobe cable, which is initially looped back to the node at the unopened MAU port.

2. Physical Insertion occurs when the node's NIC applies the phantom current to the transmit pair of the lobe cable. This activates the MAU port relay physically allowing the node into the ring.

3. Address Verification occurs next. The node verifies that it has a unique address on the ring by sending a Duplicate Address Test MAC frame out into the ring.

4. Neighbor Notification is a process whereby the new node learns its Upstream Neighbor's address and sends its address to its Downstream Neighbor.

5. Initialization Request If a Ring Parameter Server (RPS - see ring management discussion) is present on the network, the new node sends out a MAC frame to it. The RPS responds with a Ring Station MAC frame containing the station's paramenters, such as the local ring number. If no RPS is present, the node would use it default parameters.

The station is now physically and logically attached to the network.

The Active Monitor is a NIC selected by the other active nodes on the network, usually the active node with the highest numerical address. This node is designated to perform special "watchdog" functions. The process by which neighbors are identified and the active monitor is chosen is called Beaconing. The Beacon process is also used to alert downstream neighbors that a hard error has occured, such as a broken cable or defective NIC. Once the active monitor has been chosen, it clears the ring and issues a token to restart the normal ring operation.

Each NIC has monitor/ring management capabilities known as the Network Management Agent, regardless of the NIC manufacturer and based upon the IEEE 802.5 standard.

The most basic function of the Active Monitor is to provide a clocking signal for the Token Ring. All other stations on the ring "listen' to this signal and synchronize with it. The Active Monitor uses its own crystal to clock the data it transmits. The Active Monitor's next responsibility is to ensure that a Token is circulating on the ring. First, the Active Monitor makes sure that a Token can fit on the network by sending out a test. Each NIC will have a delay of 1 to 2 bit times plus the cable will have a delay based upon its length. The Active Monitor also looks for "lost" Tokens. If it does not see a Frame or a Token go by within 10 milliseconds, it clears the ring and starts a new Token.

TOKEN RING NETWORK MANAGEMENT FUNCTIONS

Each Token Ring NIC contains a Network Management "Agent" function somewhere on the board which can communicate with a Network Management "Product" located somewhere on the network. At least two vendors provide such "Products": Proteon with TokenVIEW-4 Program and IBM with the IBM LAN Manager Program. There are four functions implemented in the Product:

1.The Active and Standby Monitors which supervise the network operation.

2.The Ring Error Monitor (REM) which is responsible for collecting error reports from the NICs and Active/Standby Monitors.

3.The Configuration Report Server (CRS) which keeps track of the current network configuration, and controls individual NIC parameters such as its access priority, or signals a particular station to remove itself from the ring.

4.The Ring Parameter Server (RPS), which assigns operational parameters to the station at their time of insertion into the ring.

Agents (logic in the NIC) communicate with the Product, which could be anywhere on the ring, by using one of 25 different MAC type frames to special known addresses, one for each of the Product functions. The node, other than the NIC, is not aware of these transmissions going on. The network administrator can use this information via reports or monitors to manage and troubleshoot some network problems.

MAC frames are used for many network management/operational purposes such as:

MEDIUM CONTROL FRAMES

- BEACON
- CLAIM TOKEN
- RING PURGE
- ACTIVE MONITOR PRESENT
- STANDBY MONITOR PRESENT

ERROR MONITORING FRAMES

- REPORT ERROR
- REPORT MONITOR ERROR
- REPORT NEIGHBOR NOTIFICATION INCOMPLETE

STATION INITIALIZATION FRAMES

- LOBE MEDIA TEST
- DUPLICATE ADDRESS TEST
- REQUEST INITIALIZATION

NETWORK MANAGEMENT FRAMES

- REPORT NEW MONITOR
- REPORT STATION UPSTREAM ADDRESS CHANGE
- REMOVE RING STATION (NODE)
- CHANGE PARAMETERS
- REQUEST/REPORT STATION ADDRESS
- REQUEST/REPORT STATION STATE
- REQUEST/REPORT STATION ATTACHMENT

TOKEN RING DISTANCE LIMITATIONS

USING ANDREW CORP. MAUs

APPLICATION/SPEED	TYPE 1 (STP) CABLE	TYPE 3 (UTP) CABLE
WORKSTATION TO MAU;		
@4M bps	2000 ft/610m 22 AWG 1000 ft/305m 24 AWG	1000 ft/305m 22 AWG 500 ft/150m 24 AWG
@16M bps	1000 ft/305m 22 AWG	500 ft/150m 22 AWG
MAU-TO-MAU NO REPEATERS:		
@4M bps	1400 ft/425m 22 AWG	700 ft/210m 22 AWG
@16M bps	1000 ft/305m 22 AWG	500 ft/150m 22 AWG
MAU-TO-MAU W/REPEATERS:		
@4M bps	2400 ft/730m 22 AWG	1275 ft/385m 19 AWG 1200 ft/365m 22 AWG 1100 ft/335m 24 AWG 975 ft/300m 26 AWG
MAXIMUM DISTANCE CLOSET-TO-CLOSET	8000 ft/2435m	5000 ft/1520m
MAXIMUM WORKSTATIONS PER RING	260	72

NOTE: AS MORE MAUs ARE ADDED TO THE NETWORK, AS WELL AS MORE CLOSETS ARE USED CUTS DOWN ON THE LOBE DISTANCES.

TOKEN RING DESIGN EXAMPLE 1

Designing a Token Ring Network

Following are the steps to be taken when designing your token ring system:

1. You will need a copy of the floor plan for the area to be covered. Remember that all distances in this section apply to actual wire lengths and not to the physical separation of the units.

2. Using the enclosed worksheet, determine the location of the wiring closets and devices. Also determine the type of wiring and cabling and, for telephone wiring (Type 3), the wire gauge. Except where specified otherwise, distances given in this Planning Guide are for 22 gauge wire.

3. Using the information presented below, determine the number of MAUs and repeaters needed.

For multiple ring systems, design each ring individually based on the criteria presented for single ring systems, then locate the bridges. Bridges are usually located in a wiring closet that is accessible to both rings being bridged. Keep in mind that the lobe length requirements of both token rings must be met. Lobe length limitations for bridges are the same as for workstations.

Systems Using Telephone Wiring

A token ring network using telephone wiring can consist of up to 72 workstations using up to nine MAUs located in a single wiring closet with all lobe lengths limited to 1000 feet (305 m) or less. When these limits are exceeded, it will be necessary to add bridges to accommodate additional workstations and other devices and/or to use repeaters for larger geographical areas. In all cases, it is desirable to minimize the number of wiring closets, with one central wiring closet being ideal for small systems.

Steps for a single ring system:

Pick the most centralized wiring closet. If all planned workstations are within 1000 feet (305 m) of the central wiring closet, go to Case 1. If not, proceed to Case 2.

Case 1 - All MAUs in one central wiring closet.

1. To determine the number of MAUs needed, divide the number of workstations by 8.

2. Determine the type of MAUs needed. For workstations located within 500 feet (150 m) of the wiring closet, 8220 series MAUs can be used. For workstations located within 1000 feet (305 m) of the wiring closet, use 9220 series MAUs.

Case 2 - MAUs in more than one wiring closet.

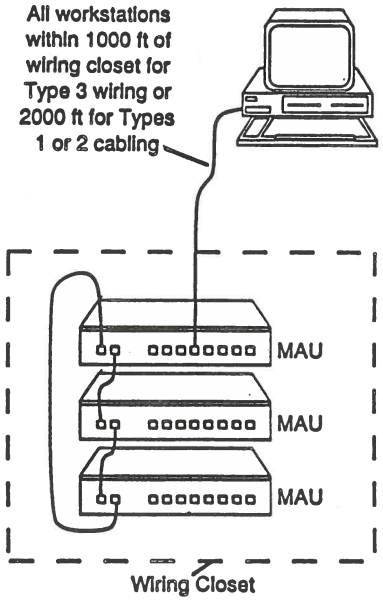
1. All workstations must be within 1000 feet (305 m) of a wiring closet. Keeping in mind this distance limitation, plan your network to use the fewest number of wiring closets possible.

2. Repeaters are recommended for most networks having more than one wiring closet. Where repeaters are used, a pair is required for each connection between wiring closets separated by 1200 feet (365 m) or less. Additional repeaters can be used for distances up to 5000 feet (1520 m). If you do not plan to use repeaters, refer to Appendix B for calculation of distance limitations between the wiring closet and workstations.

Perform steps 3 and 4 individually for each wiring closet.

3. To determine the number of MAUs needed, divide the number of workstations by 8.

4. Determine the type of MAUs needed. For workstaions located within 500 feet (150 m) of the wiring closet, 8220 series MAUs can be used. For workstations located within 1000 feet (305 m) of the wiring closet, use 9220 series MAUs.



Case 1 - All MAUs in one Central Wiring Closet

TOKEN RING DESIGN EXAMPLE 2

Systems Using Shielded Cable (Type 1 or 2)

A token ring network using shielded cable can consist of up to 260 workstations using up to 33 MAUs located in a single wiring closet with all lobe lengths limited to 2000 feet (610 m) or less. When these limits are exceeded, it will be necessary to add bridges to accommodate additional workstations and other devices and/or to use repeaters for larger geographical areas. In all cases, it is desirable to minimize the number of wiring closets, with one central wiring closet being ideal for small systems.

Steps for a single ring system:

Pick the most centralized wiring closet. If all planned workstations are within 2000 feet (610 m) of the central wiring closet, go to Case 1. If not, proceed to Case 2.

Case 1 - All MAUs in one central wiring closet.

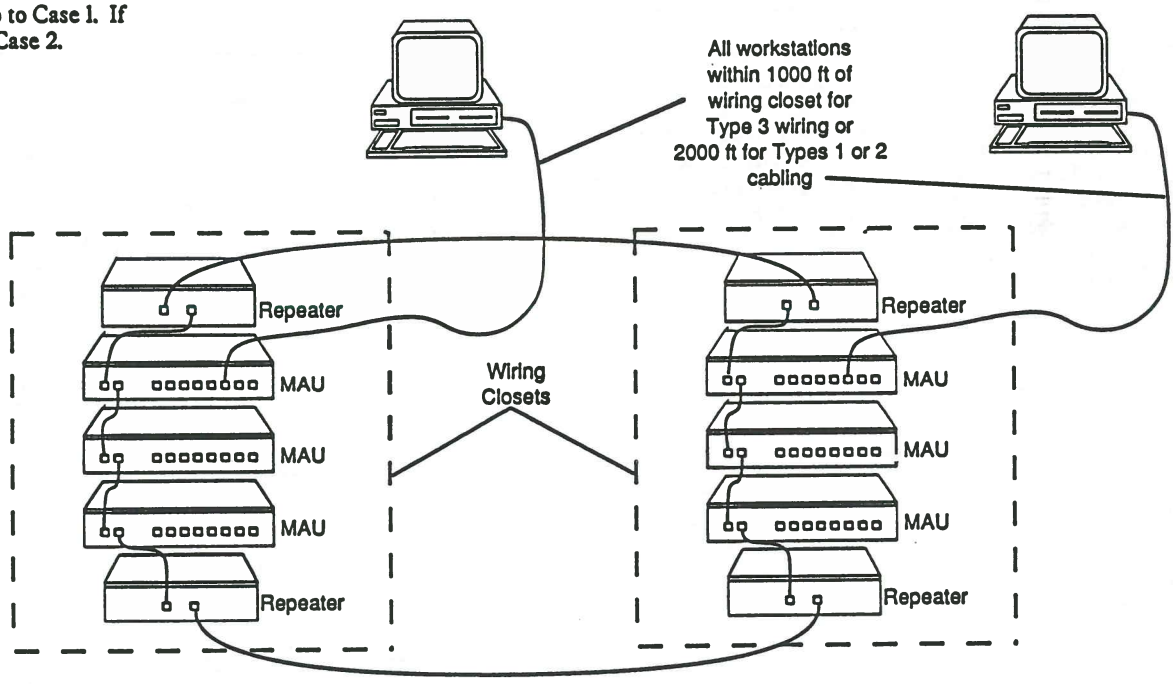
1. To determine the number of MAUs needed, divide the number of workstations by 8.
2. Determine the type of MAUs needed. For workstations located within 1000 feet (305 m) of the wiring closet, 8220 series MAUs can be used. For workstations located within 2000 feet (610 m) of the wiring closet, use 9220 series MAUs.

Case 2 - MAUs in more than one wiring closet.

1. All workstations must be within 2000 feet (610 m) of a wiring closet. Keeping in mind this distance limitation, plan your network to use the fewest number of wiring closets possible.
2. Repeaters are recommended for most networks having more than one wiring closet. Where repeaters are used, a pair is required for each connection between wiring closets separated by 2400 feet (730 m) or less. Additional repeaters can be used for distanced up to 8000 feet (2435 m). If you do not plan to use repeaters, refer to Appendix C for calculation of distance limitations between the wiring closet and workstations.

Perform steps 3 and 4 individually for each wiring closet.

3. To determine the number of MAUs needed, divided the number of workstations by 8.
4. Determine the type of MAUs needed. For workstations located within 1000 feet (305 m) of the wiring closet, 8220 series MAUs can be used. For workstations located within 2000 feet (610 m) of the wiring closet, use 9220 series MAUs.



Case 2 - MAUs in more than one Wiring Closet

Courtesy NCR Corporation

TOKEN RING DESIGN EXAMPLE 3

Appendix B

Calculation of Maximum Lobe Length When Repeaters Are Not Used - Telephone Wiring (Type 3)

In this Appendix, distance specifications are based on connections using telephone cable (Type 3). All distances apply to actual wire lengths and not to the physical separation of the units.

For the most efficient token ring network, all MAUs should be placed in a single centrally located wiring closet. However, this is not always possible or practical. It may be necessary to locate MAUs for a ring in two or more wiring closets. When MAUs are separated geographically, the allowable lobe length may be significantly reduced. This Appendix presents a simplified method to calculate the maximum lobe length when MAUs are separated geographically and repeaters are not used. When repeaters are used, allowable lobe lengths are not reduced and these calculations do not apply.

If all MAUs in the ring are of the same series (either 8220 series or 9220 series) select the method in Case 1. If both 8220 and 9220 series MAUs are used in a ring, select Case 2.

Case 1 - Either 8220 or 9220 Series MAUs (Not Both)

Figure 1 shows a system having four MAUs located in three wiring closets. The maximum lobe length for a system having multiple wiring closets can be calculated using the following formula:

LMAX = [MTD] - [ARL]

where:

LMAX is Maximum Lobe Length

MTD is Maximum Transmission Distance (defined below)

and

ARL is Adjusted Ring Length (defined below)

As explained in earlier sections of this Guide, the Maximum Lobe Length (LMAX) cannot exceed 500 feet (150 m) for 8220 series MAUs and 1000 feet (305 m) for 9220 series MAUs. Therefore, if the calculated value for LMAX is higher than the 500 or 1000 foot limits, 500 or 1000 feet should be used.

Maximum Transmission Distance is a function of the number of MAUs, the number of wiring closets and the wire gauge. Values for calculation purposes are shown in Tables 1 and 2.

Adjusted Ring Length is the total length of the cable connecting the MAUs minus all patch cord lengths and the shortest inter-closet cable. For example, the Adjusted Ring Length for the ring in Figure 1 is:

ARL = 35 + 60 = 90 feet

The patch cable (1 foot) and the shortest inter-closet cable (30 feet) are excluded from the calculations.

For networks using 9220 series MAUs, the ARL must be within the maximum values specified in Table 2.

Sample Calculation

Find the maximum lobe length for the network in Figure 1 using either 8220 series or 9220 series MAUs and 24 gauge Type 3 wiring.

LMAX = [MTD] - [ARL]

For 8220 Series MAU:

MTD = 435 (From Table 1)

ARL = 95 (Explained above)

LMAX = 435 - 95 = 340 feet

340 feet is within the allowable maximum of 500 feet for 8220 series MAUs, so the maximum lobe length is 340 feet.

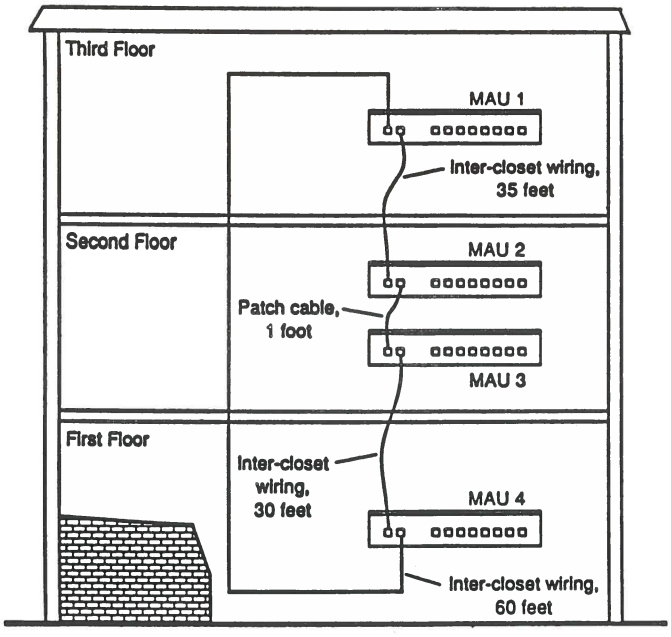


Figure 1

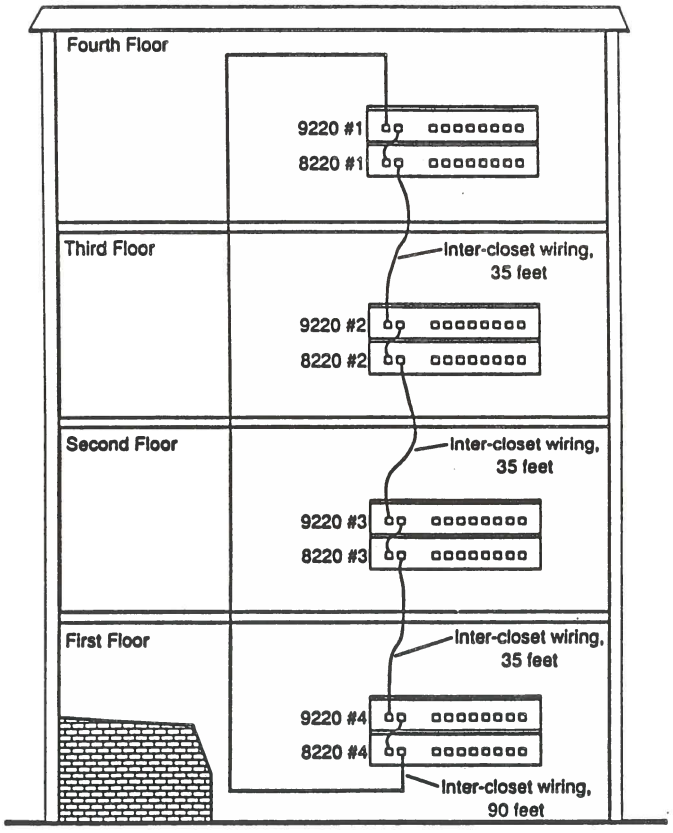


Figure 2

Courtesy NCR Corporation

TOKEN RING DESIGN EXAMPLE 4

For 9220 Series MAU:

MTD = 1400 (From Table 3)

ARL = 95 (Explained above)

LMAX = 1400 - 95 = 1305 feet

1305 feet is greater than the allowable maximum of 1000 feet for 9220 series MAUs, so the maximum lobe length is 1000 feet.

The ARL of 95 is within the maximum of 790 specified in Table 2.

Case 2 - Both 8220 and 9220 Series MAUs

A token ring network using both 8220 and 9220 series MAUs is shown in Figure 2. The procedure for calculation of maximum lobe length is similar to that explained above, except the maximum transmission distances are different for the 8220 series and the 9220 series MAUs.

Adjusted ring length is calculated the same as above. For the network in Figure 2, it is:

ARL = 30 + 30 + 90 = 150 feet

The patch cables and shortest inter-closet cable (30 feet) are excluded from the calculations.

To find the Maximum Transmission Distances for the 8220 series MAUs, count the total number of MAUs in the ring (count both 8220 and 9220 series) and count the number of wiring closets. Use Table 1 for 8220 series MAUs.

To find the maximum transmission distances for the 9220 series MAUs, count the number of 9220 series MAUs in the ring and the number of wiring closets. Use Table 3 for 9220 series MAUs.

Sample Calculation

Find the maximum lobe length using 24 gauge telephone wire for the network in Figure 2. The ring includes both 8220 series and 9220 series MAUs.

LMAX = [MTD] - [ARL]

For 8220 Series MAU:

MTD = 365 (From Table 3)

ARL = 150 (Explained above)

LMAX = 365 - 150 = 215 feet

215 feet is within the allowable maximum of 500 feet for 8220 series MAUs, so the maximum lobe length is 215 feet.

For 9220 Series MAU:

MTD = 1360 (From Table 1)

ARL = 150 (Explained above)

LMAX = 1360 - 150 = 1210 feet

1210 feet is greater than the allowable maximum of 1000 feet for 9220 series MAUs, so the maximum lobe length is 1000 feet.

The ARL of 150 is within the 780 foot maximum specified in Table 2.

Table 1 - Maximum Transmission Distance Using 8220 Series MAU and Telephone Wiring, feet (m)

Number of MAUs	Number of Wiring Closets 1	2	3	4	5
19 Gauge Wire					
1	600 (185)				
2	585 (180)	575 (175)			
3	570 (175)	560 (170)	550 (170)		
4	555 (170)	545 (165)	535 (165)	525 (160)	
5	540 (165)	530 (160)	520 (160)	510 (155)	500 (150)
6	525 (160)	515 (155)	505 (155)	495 (150)	485 (150)
7	510 (155)	500 (150)	490 (150)	480 (145)	470 (145)
8	495 (150)	485 (150)	475 (145)	465 (140)	455 (140)
22 Gauge Wire					
1	550 (170)				
2	535 (165)	525 (160)			
3	520 (160)	510 (155)	500 (150)		
4	505 (155)	495 (150)	485 (150)	475 (145)	
5	490 (150)	480 (145)	470 (145)	460 (140)	450 (135)
6	475 (145)	465 (140)	455 (140)	445 (135)	435 (135)
7	460 (140)	450 (135)	440 (135)	430 (130)	420 (130)
8	445 (135)	435 (135)	425 (130)	415 (125)	405 (125)
24 Gauge Wire					
1	500 (150)				
2	485 (150)	475 (145)			
3	470 (145)	460 (140)	450 (135)		
4	455 (140)	445 (135)	435 (135)	425 (130)	
5	440 (135)	430 (130)	420 (130)	410 (125)	400 (120)
6	425 (130)	415 (125)	405 (125)	395 (120)	385 (115)
7	410 (125)	400 (120)	390 (120)	380 (115)	370 (115)
8	395 (120)	385 (115)	375 (115)	365 (110)	355 (110)
26 Gauge Wire					
1	470 (145)				
2	455 (440)	445 (135)			
3	440 (135)	430 (130)	420 (130)		
4	425 (130)	415 (125)	405 (125)	395 (120)	
5	410 (125)	400 (120)	390 (120)	380 (115)	370 (115)
6	395 (120)	385 (115)	375 (115)	365 (110)	355 (110)
7	380 (115)	370 (115)	360 (110)	350 (105)	340 (105)
8	365 (110)	355 (110)	345 (105)	335 (100)	325 (100)

Courtesy NCR Corporation

TOKEN RING DESIGN EXAMPLE 5

Table 2 - Maximum Adjusted Ring Length (ARL) Using 9220 Series MAU and Telephone Wiring, feet (m)

Number of MAUs	Number of Wiring Closets 2	3	4	5
19 Gauge Wire				
2	780 (240)			
3	770 (235)	930 (285)		
4	760 (230)	890 (270)	820 (250)	
5	745 (225)	860 (260)	790 (240)	760 (230)
6	730 (225)	830 (255)	760 (230)	730 (225)
7	715 (220)	800 (245)	725 (220)	695 (210)
8	700 (215)	7760 (235)	690 (210)	660 (200)
22 Gauge Wire				
2	740 (225)			
3	730 (225)	920 (280)		
4	720 (220)	880 (270)	800 (245)	
5	710 (215)	850 (260)	770 (235)	750 (230)
6	700 (215)	820 (250)	740 (225)	715 (220)
7	690 (210)	790 (240)	705 (215)	680 (205)
8	680 (205)	760 (230)	670 (205)	640 (195)
24 Gauge Wire				
2	700 (215)			
3	690 (210)	890 (270)		
4	680 (205)	860 (260)	780 (240)	
5	670 (205)	830 (255)	750 (230)	730 (225)
6	660 (200)	800 (245)	720 (220)	695 (210)
7	650 (200)	765 (235)	690 (210)	660 (200)
8	640 (195)	730 (225)	660 (200)	625 (190)
26 Gauge Wire				
2	650 (200)			
3	630 (190)	770 (235)		
4	610 (185)	700 (215)	680 (205)	
5	590 (180)	650 (200)	630 (190)	610 (185)
6	570 (175)	610 (185)	585 (180)	570 (175)
7	555 (170)	580 (175)	555 (170)	535 (165)
8	540 (165)	550 (170)	525 (160)	500 (150)

Table 3 - Maximum Transmission Distance Using 9220 Series MAU and Telephone Wiring, feet (m)

Number of MAUs	Number of Wiring Closets 1	2	3	4	5
19 Gauge Wire					
1	1050 (320)				
2	1050 (320)	1365 (415)			
3	1050 (320)	1340 (410)	1500 (455)		
4	1050 (320)	1315 (400)	1460 (445)	1430 (435)	
5	1050 (320)	1290 (395)	1410 (430)	1380 (420)	1340 (410)
6	1050 (320)	1265 (385)	1350 (410)	1330 (405)	1290 (395)
7	1050 (320)	1240 (380)	1280 (390)	1260 (385)	1235 (375)
8	1050 (320)	1215 (370)	1230 (375)	1180 (360)	1160 (355)
22 Gauge Wire					
1	1000 (305)				
2	1000 (305)	1350 (410)			
3	1000 (305)	1325 (405)	1475 (450)		
4	1000 (305)	1300 (395)	1435 (435)	1400 (425)	
5	1000 (305)	1270 (385)	1385 (420)	1350 (410)	1320 (400)
6	1000 (305)	1240 (380)	1335 (405)	1300 (395)	1270 (385)
7	1000 (305)	1210 (370)	1275 (390)	1250 (380)	1215 (370)
8	1000 (305)	1180 (360)	1215 (370)	1190 (365)	1160 (355)
24 Gauge Wire					
1	950 (290)				
2	950 (290)	1300 (395)			
3	950 (290)	1275 (390)	1430 (435)		
4	950 (290)	1250 (380)	1400 (425)	1360 (415)	
5	950 (290)	1225 (375)	1360 (415)	1310 (400)	1280 (390)
6	950 (290)	1200 (365)	1320 (400)	1260 (385)	1230 (375)
7	950 (290)	1175 (360)	1280 (390)	1210 (370)	1180 (360)
8	950 (290)	1150 (350)	1230 (375)	1160 (355)	1130 (345)
26 Gauge Wire					
1	850 (260)				
2	850 (260)	1150 (350)			
3	850 (260)	1120 (340)	1250 (380)		
4	850 (260)	1090 (330)	1210 (370)	1190 (365)	
5	850 (260)	1060 (325)	1170 (355)	1130 (345)	1110 (340)
6	850 (260)	1030 (315)	1120 (340)	1070 (325)	1050 (320)
7	850 (260)	1000 (350)	1060 (325)	1010 (310)	1000 (305)
8	850 (260)	970 (295)	990 (300)	950 (290)	930 (285)

Courtesy NCR Corporation

TOKEN RING DESIGN EXAMPLE 6

Appendix C

Distance Specifications Using Shielded Cable (Type 1 or 2) for the Main Ring

In this Appendix, distance specifications are based on connections in the main ring using shielded cable. Lobe connections are made using shielded cable or telephone wire (Types 1, 2, or 3).

9220 series MAUs support lobe distances up to 2000 feet (610 m) of shielded cable or up to 1000 feet (305 m) of telephone wire, depending on the size of the main ring.

8220 series MAUs support lobe distances up to 1000 feet (305 m) of shielded cable or up to 500 feet (150 m) of telephone wire, depending on the size of the main ring.

Using 9220 Series MAUs and No Repeaters

Table 4 show the maximum Adjusted Ring Length (ARL, defined on page 16) for a ring having the longest lobe from 1000 to 2000 feet (305 to 610 m) of shielded cable or 500 to 1000 feet (150 to 305 m) of telephone wire. In addition to the longest lobe length, the maximum ARL is a function of the number of MAUs and number of wiring closets.

Table 5 shows the maximum ARL for a ring having the longest lobe up to 1000 feet (305 m) of shielded cable or up to 500 feet (150 m) of telephone wire.

To use the tables:

1. Select Table 4 or Table 5 based on the length of the longest lobe.
2. Find maximum ARL from the table.
3. Calculate actual ring ARL (This calculation is explained on page 16).
4. If actual ARL is less than the maximum ARL the ring will operate without need for repeaters. If the actual ARL is greater than the maximum, repeaters will be needed.

Example

Determine whether or not the configuration shown in Figure 3 will operate without repeaters. The main ring uses Type 1 cable and the lobes use Type 3 cable.

1. Since Longest Lobe Length is 400 feet, use Table 5.
2. Maximum ARL from Table 5 is 1300 feet.
3. Actual ARL is 100 + 180 = 280 feet.
4. The actual ARL of 280 feet is less than the 1300 foot maximum, so the ring will operate without repeaters.

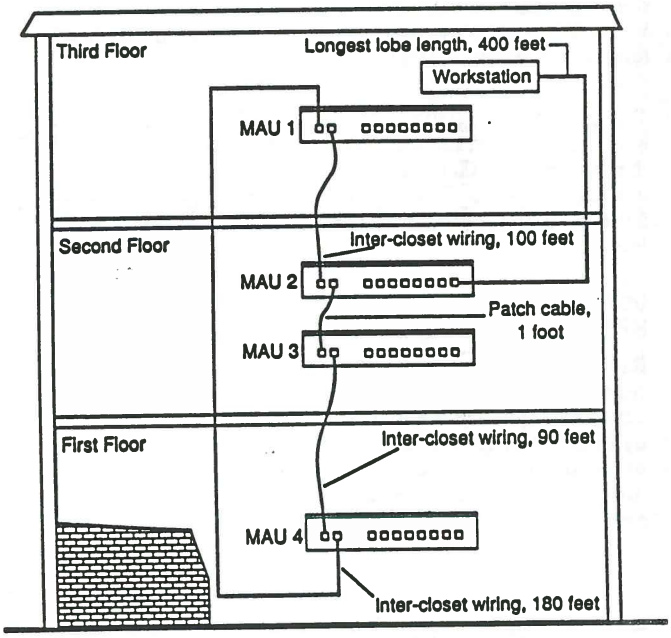


Figure 3

Table 4 - For longest Lobe Length 1000 to 2000 feet (305 to 610 m) Using Shielded Cable or 500 to 1000 feet (150 to 305 m) of 24 Gauge Telephone Wire

Maximum ARL, feet (m) Using Shielded Cable

Number of MAUs	Number of Wiring Closets 2	3	4	5	6	7	8
2	700 (215)						
3	680 (205)	850 (260)					
4	660 (200)	810 (245)	750 (230)				
5	640 (195)	770 (235)	710 (215)	700 (215)			
6	620 (190)	730 (220)	700 (215)	690 (210)	680 (205)		
7	600 (180)	700 (215)	690 (210)	680 (205)	670 (205)	660 (200)	
8	580 (175)	690 (210)	680 (205)	670 (205)	660 (200)	650 (200)	640 (585)

Table 5 - For longest Lobe Length up to 1000 feet (305 m) of Shielded Cable or up to 500 feet (150 m) of 24 Gauge Telephone Wire

Maximum ARL, feet (m) Using Shielded Cable

Number of MAUs	Number of Wiring Closets 2	3	4	5	6	7	8
2	1100 (335)						
3	1075 (325)	1300 (395)					
4	1050 (320)	1250 (380)	1200 (365)				
5	1025 (310)	1200 (365)	1140 (345)	1050 (320)			
6	1000 (305)	1170 (355)	1100 (335)	1030 (315)	1000 (305)		
7	975 (295)	1140 (345)	1070 (325)	1000 (305)	975 (295)	925 (280)	
8	950 (290)	1100 (335)	1040 (315)	980 (300)	950 (290)	900 (275)	850 (260)

Courtesy NCR Corporation

TOKEN RING DESIGN EXAMPLE 7

For segments that contain more than one 9220 series MAU, the maximum total distance between MAUs is the same as the maximum ARL allowed for rings not using repeaters. Use Table 4 for segments that require lobe lengths of 1000 to 2000 feet (305 to 610 m) of Type 1 or 2 cable or 500 to 1000 feet (150 to 305 m) of Type 3 cable. Use Table 5 for segments that require lobe lengths of up to 1000 feet (305 m) of Type 1 or 2 cable or up to 500 feet (150 m) of Type 3 cable.

Example

Find the maximum total distance between MAUs for the ring segment show in Figure 7 having a longest lobe length of 800 feet of Type 1 cable.

The maximum total distance between MAUs is the same as the maximum ARL for a ring without repeaters. From Table 5 the maximum distance is 1100 feet.

Using 8220 Series MAUs and RPTR-8218 Repeaters

RPTR-8218 token ring repeaters allow geographical expansion of existing networks by dividing rings into individual segments that have distance limitations independent of each other.

For segments that do not contain MAUs, up to 2400 feet (730 m) of Types 1 and 2 cable is allowed between repeaters.

For segments that contain 8220 series MAUs, the allowable distance between MAUs, from repeaters to MAUs and the length of the longest lobe all depend on one another.

To determine ring segment distance limitations, first calculate the actual Ring Segment Drive Distance, as explained below, and compare it with the Maximum Ring Segment Drive Distance from Table 8.

To calculate Ring Segment Drive Distance:

1. Determine length of the longest lobe for Type 1 or 2 cables. For Type 3 cable, multiply the actual length by 2 to obtain the value for calculation purposes.

2. Determine the length of the cable between each repeater and the closest 8220 series MAU within the segment.

3. If the length of the longest lobe is greater than the length of both of the cables between the repeater and the closest MAU, the drive distance is the sum of the length of the longest lobe and the length of all cables between the first and last MAU in the ring segment.

If the length of the longest lobe is less than the length of one or both of the cables between the repeater and the closest MAU, the drive distance is the sum of the longer of the two lengths of cable and the length of all cables between the first and last MAU in the ring segment.

Example

Determine the suitability of the configuration shown in Figure 8.

1. Longest Lobe Length is 100 feet. For Type 3 cable, multiply by 2 for calculation purposes: 100 x 2 = 200

2. Length of cables between each repeater and the closest MAU are 350 feet and 100 feet.

3. 200 foot Longest Lobe Length, from step 1, is less than the 350 foot length from step 2. Therefore the Drive Distance is 350 + 50 = 400 feet.

4. From Table 8 the Maximum Drive Distance for two MAUs and two wiring closets is 1175 feet. Therefore, the configuration is acceptable.

Table 8 - Maximum Ring Segment Drive Distances, feet (m)

Number of MAUs	Number of Wiring Closets 1	2	3	4	5	6	7	8
1	1220 (370)							
2	1195 (365)	1175 (360)						
3	1170 (355)	1150 (350)	1130 (345)					
4	1145 (350)	1125 (340)	1105 (335)	1085 (330)				
5	1120 (340)	1100 (335)	1080 (330)	1060 (325)	1040 (315)			
6	1095 (335)	1075 (325)	1055 (320)	1035 (315)	1015 (310)	995 (305)		
7	1070 (325)	1050 (320)	1030 (315)	1010 (310)	990 (300)	970 (295)	950 (290)	
8	1045 (320)	1025 (310)	1005 (305)	985 (300)	965 (295)	945 (290)	925 (280)	905 (275)

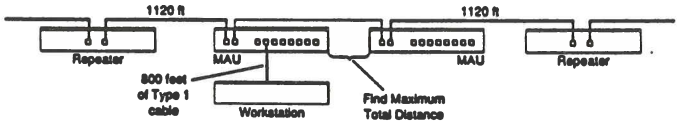


Figure 7

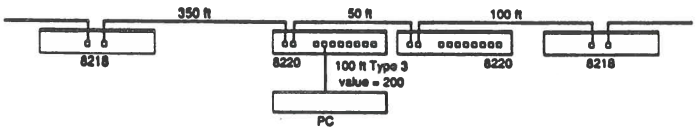


Figure 8

TOKEN RING DESIGN EXAMPLE 8

Using 8220 Series MAUs and No Repeaters

When using 8220 series MAUs, the maximum lobe length can be calculated using the formulas below.

For Type 1 or 2 cable:

$$LMAX = [MTD] - [ARL]$$

For Type 3 cable:

$$LMAX = \frac{[MTD] - [ARL]}{2}$$

Where:

LMAX is maximum lobe length

MTD is Maximum Transmission Distance (defined below)

and,

ARL is Adjusted Ring Length (defined below)

Maximum Transmission Distance (MTD) is a function of the number of MAUs and the number of wiring closets. Values for calculation purposes are listed in Table 6.

Adjusted Ring Length (ARL) is the total length of the cable connecting the MAUs minus all patch cord lengths and the shortest inter-closet cable. For an example of how to calculate ARL see page 16.

Example

Find the maximum lobe length, using Type 3 cable, for the ring shown in Figure 4. The main ring uses Type 1 cable.

$$LMAX = \frac{[MTD] - [ARL]}{2}$$

MTD = 1120 feet (from Table 6)

ARL = 100 + 180 = 280 feet

$$LMAX = \frac{1120-280}{2} = 420 \text{ feet}$$

Table 6 - Maximum Transmission Distance, feet (m)

Number of MAUs	Number of Wiring Closets 2	3	4	5	6	7	8
2	1200 (365)						
3	1170 (355)	1150 (350)					
4	1140 (345)	1120 (340)	1100 (335)				
5	1110 (340)	1090 (330)	1070 (325)	1050 (320)			
6	1080 (330)	1060 (325)	1040 (315)	1020 (310)	1000 (305)		
7	1050 (320)	1030 (315)	1010 (305)	990 (300)	970 (295)	950 (290)	
8	1020 (310)	1000 (305)	980 (300)	960 (295)	940 (285)	920 (280)	900 (275)

Table 7 - Maximum Repeater to MAU-9220 Distance, feet (m)

MAUs Within Segment 1	2	3	4	5	6	7	8
1150 (350)	1120 (340)	1090 (330)	1060 (325)	1030 (315)	1000 (305)	970 (295)	940 (285)

Using 9220 Series MAUs and RPTR-8218 Repeaters

RPTR-8218 token ring repeaters allow geographical expansion of existing networks by dividing rings into individual ring segments that have distance limitations independent of each other. A ring segment is the portion of the ring between any two token ring repeaters. The ring segment may or may not include any MAUs.

For segments that do not contain MAUs, up to 2400 feet (730 m) of Types 1 and 2 cable is allowed between repeaters.

For segments that contain 9220 series MAUs, the longest lobe distance, the distance between MAUs within the segment and the larger of the two MAU to repeater distances must be determined. Table 7 specifies the maximum repeater to MAU distance. This value is independent of the distance between MAUs and the length of the longest lobe.

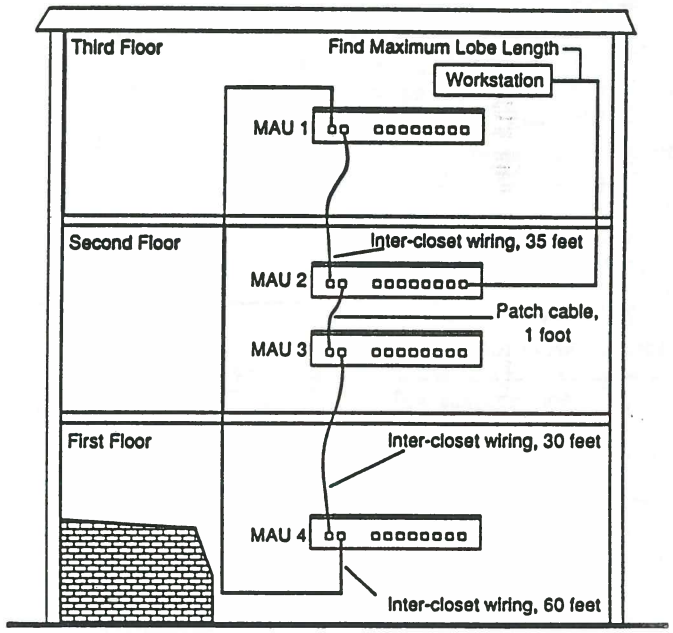


Figure 4

Figure 5

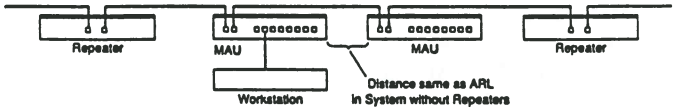


Figure 6

TOKEN RING DESIGN EXAMPLE 9

Ordering Information

Multistation Access Units (MAUs)

Eight-port units are designed for rack mounting. Dimensions in inches are: 1.7 high x 5 deep x 16.2 wide (44 x 126 x 412 mm).

Four-port units mount to a desk or wall. Dimensions in inches are: 1.7 high x 5 deep x 11.4 wide (44 x 126 x 288 mm).

Power Requirements. Switchable 115/230 VAC, 6 watts.

Optional Rack Mounting Kit for 4-port units, Type Number **RM-ADAPT**

Repeaters

Repeaters mount to a desk or wall. Dimensions in inches are: 1.7 high x 5 deep x 11.4 wide (44 x 126 x 288 mm).

Power Requirements. Switchable 115/230 VAC, 8 watts.

Optional Rack Mounting Kit, Type Number **RM-ADAPT**

Adaptor Cards

Adaptor cards fit into the expansion slot of a personal computer and interface with Type 1, 2 or 3 cabling media. All are compatible with IBM LAN Program with DOS version 3.3 or higher and LAN support program or Novell's Advanced NetWare, ELS NetWare or SFT NetWare.

Power Requirement: 5 VDC, 1.5 amp max.

Bridges

Bridges mount to a standard 19-inch equipment rack and occupy two standard spaces. Dimensions in inches are: 3.5 high x 14 deep x 19 wide (89 x 356 x 483 mm).
Two DB-9 connectors are mounted in the front panel. Green, yellow and red status LEDs are provided for each token ring.

Power Requirements: Switchable 115/230 VAC, 35 watts.

Bridge Management Program - Model No. **BGPT-7010**

Multistation Access Units (MAUs)

Model Number	Port	Type	Connector	Data Rate	Max. Lobe Length ft (m)
For Telephone Wiring (Type 3)					
MAU-9228	8	Extended Distance	RJ11/RJ45	4 Mb	1000 (305)
MAU-9224	4	Extended Distance	RJ11/RJ45	4 Mb	1000 (305)
MAU-8228	8	Standard	RJ11/RJ45	4 Mb/16 Mb	500 (150)
MAU-8224	4	Standard	RJ11/RJ45	4 Mb/16 Mb	500 (150)
For Shielded Cabling (Type 1 or 2)					
MAU-9228 -DC8		Extended Distance	Data	4 Mb	2000 (610)
MAU-8228 -DC8		Standard	Data	4 Mb/16 Mb	1000 (305)

Repeaters

Model Number	Cabling	Connectors	Data Rate	Wire Gauge	Max Transmission Distance Feet (m)
RPTR-8218	Type 3	RJ11/RJ45	4 Mb	19	1275 (390)
				22	1200 (365)
				24	1100 (335)
				26	975 (295)
RPTR-8218-DC	Type 1 or 2	Data	4 Mb	-	2400 (730)

Adaptor Cards

Model Number	For IBM Personal Computer Type*	RAM Buffer	Data Rate	Connector
TRA-PC	PC,XT	18 Kb	4 Mb	DB-9
TRA-AT	AT	18 Kb	4 Mb	DB-9
TRA-MCA	PS/2	18 Kb	4 Mb	DB-9

*Or equivalent compatible type. Requires 256 Kb RAM and one full size expansion slot.

Bridges

Model Number	Data Rate	Local or Remote
BGPT-7404	4 Mb to 4 Mb	Local
BGPT-7604	4 Mb to 16 Mb	Local
BGPT-7412	4 Mb to 4 Mb	Remote (2.048 Mb)

Media Filters and Patch Cords

Media Filter. Required for networks using telephone wiring (Type 3). DB-9 connector plugs into adaptor card. Cable length is 10 feet (3.0 m).* Connects to cabling using RJ11 or RJ45 connector.

4 Mb with RJ11 Connector - Model No. CT-4-RJ11

4 Mb with RJ45 Connector - Model No. CT-4-RJ45

16 Mb with RJ11 Connector - Model No. CT-16-RJ11

16 Mb with RJ45 Connector - Model No. CT-16-RJ45

4 Mb with Data Connector - Model No. CT-4-DC

16 Mb with Data Connector - Model No. CT-16-DC

Patch Cords connect RJ11 to data connector.

1 ft (0.3 m) length*-Model No. TR-100

4 ft (1.2 m) length*-Model No. TR-400

Patch Cord DB-9 to data connector for connection from adaptor card to IBM cabling system, 10 ft (3.0 m) length*-Model No. TRDC-10

*Other lengths available on request.

TOKEN RING/NETBIOS FRAME FORMAT

IEEE 802.5 TOKEN RING FRAME FORMAT

SD	AC	FC	DA	SA	RI	INFORMATION FIELD	FCS	ED	FS	
8	8	8	48	48	0-18	8*M	32	8	8	BITS

SD = START DELIMITER
AC = ACCESS CONTROL
FC = FRAME CONTROL
DA = DESTINATION ADDRESS
SA = SOURCE ADDRESS
RI = SOURCE ROUTING INFO. (IBM)
FCS = FRAME CHECK SEQUENCE
ED = END DELIMITER
FS = FRAME STATUS

DSAP = DESTINATION SERVICE ACCESS POINT (FØ FOR NETBIOS)

SSAP = SOURCE SERVICE ACCESS POINT (FØ FOR NETBIOS)

IEEE 802.2 LOGICAL LINK CONTROL FRAME

DSAP	SSAP	CONTROL	INFORMATION	
8	8	8-16	8*M	BITS

LG = LENGTH OF FRAME
CMD = NETBIOS COMMAND
OPT1 = OPTIONAL DATA 1
OPT2 = OPTIONAL DATA 2
X/R = TRANSMIT/RESPONSE CORRELATOR

THE NETBIOS, OR ANY OTHER UPPER LAYER HEADER WITH OR WITHOUT END USER DATA IS PLACED INSIDE THE LLC FRAME WHICH IS THEN PLACED INSIDE OR ENCAPSULATED BY THE MAC LAYER HEADER TO COMPLETE THE 802.5 TOKEN RING FRAME FORMAT. THIS IS THEN DELIVERED ACROSS THE LAN TO THE PROPER NODE.

NETBIOS HEADER

LG	CMD	OPT1	OPT2	X/R	DN	SN	OPTIONAL
16	8	8	16	24			DATA

16 16
CHARACTERS

OTHER SERVICE ACCESS POINT EXAMPLES

ØØ - Null
Ø2 - LLC MANAGEMENT
Ø4 - SNA PATH CONTROL
Ø6 - ARPANET'S INTERNET
8Ø - 3COM XNS
AA - TCP/IP
EØ - NOVELL
F4 - LAN MANAGEMENT
F8 - IBM REMOTE PROGRAM LOAD
FE - ISO NETWORK LAYER
FF - GLOBAL

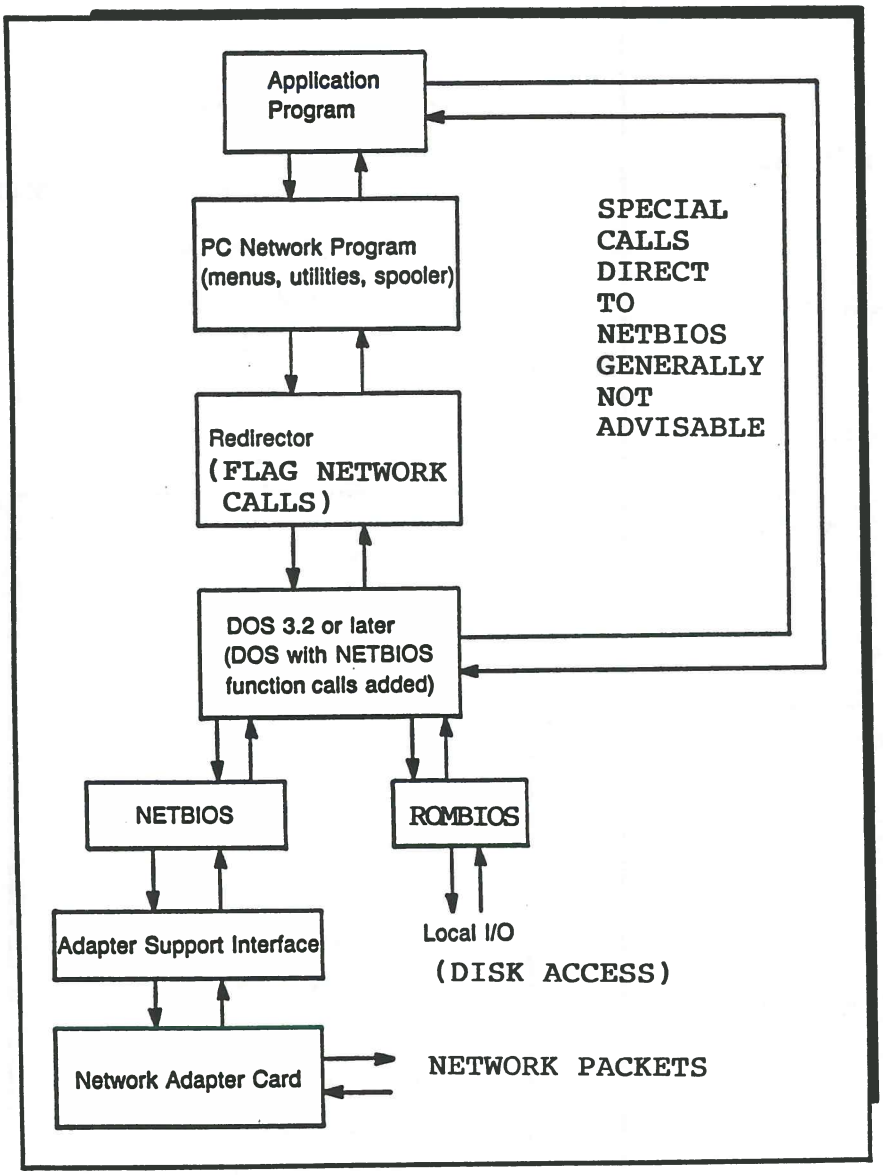
NETBIOS FRAMES AND FUNCTIONS

NetBIOS (Network Basic Input Output System) was developed by Sytek, Inc. and IBM as a programming interface to IBM's PC Network LAN and originally was implemented on the PC Network NIC itself. However, for the Token Ring network, as well as others, NetBIOS functions are now emulated in the PC with software provided with the NIC. It provides an interface between the applications and the network such that standard commands are invoked to perform certain network fucntions such as send, receive, confirm, status-query, add-group-name, etc. Many application programs are NetBIOS compatible, which means they use the NetBIOS command calls to access the network. NetBIOS is often called an Application Programming Interface or API for this reason.

Compared to the OSI model duties, NetBIOS performs at the Session layer, one that is responsible for establishing and terminating the sessions between two users on a network, often this is between a workstation and a server. As NetBIOS functions are not strong at the lower layers, Transport and Network, frequently other protocols are used along with NetBIOS, such as TCP/IP or vendor specific protocols such as Novell's IPX/SPX.

When using NetBIOS, the node builds a Network Control Block (NCB) and transmits the appropriate NetBIOS frame, which is encapulated in the LLC and MAC frames for use on the LAN.

IBM'S NETBIOS FUNCTIONS



THE IBM PC NETWORK PROGRAM IN 1985 CONTAINED A SUBNETWORK PIECE CALLED NETBIOS - NETWORK BASIC INPUT/OUTPUT SYSTEM.

ALSO AT THE SAME TIME IBM CAME OUT WITH DOS3.1, WHICH INCLUDED NETWORK SUPPORT. THIS PROVIDED RECORD, FILE, AND PERIPHERAL LOCKING TO DOS PERMITTING MULTIPLE USERS TO ACCESS AND MODIFY DATA. IT PROVIDED NETWORKING AND APPLICATION PROGRAMMERS WITH A SET OF STANDARDS THEY COULD USE IN DEVELOPING NETWORK SOFTWARE.

NETBIOS HANDLES ALL COMMUNICATIONS BETWEEN THE APPLICATION AND THE NETWORK ADAPTER. IT IS AN API FOR APPLICATIONS

THERE ARE TWO VERSIONS - TOKEN RING NETBIOS IS PROVIDED BY PROGRAMS THAT ARE INSTALLED IN THE PC AND RUN LIKE OTHER PROGRAMS, FOR THE BROAD-BAND NETWORK NETBIOS IS PROVIDED IN ROM ON THE BROADBAND ADAPTER CARD.

A SERIOUS DEFICIENCY OF NETBIOS IS THAT IT DOES NOT PROVIDE A STANDARD FOR INTERNETWORKING AND COMMUNICATIONS BEYOND THE LOCAL AREA NETWORK. DOS DOES NOT PROVIDE MULTITASKING, WHICH FURTHER RESTRICTS NETBIOS CAPABILITIES.

NETBIOS INTERFACES

SAMPLE SUPPORTED PROGRAMS

APL Version 1
Basic Compiler Version 1
Basic Interpreter Version 3.1
Binary Synchronous 3270 Emulation Version 1
COBOL Compiler Version 1
DisplayWrite 1
DisplayWrite 3 Version 1
DisplayWrite Legal Support Version 1
DisplayWrite Medical Support Version 1
FileCommand Version 1
FORTRAN Compiler Version 2
Graphical Kernel System Version 1
Graphics Development Toolkit Version 1
Graphics File System Version 1
IBM Business Management Series Application Editions with Local Area Network Access Edition*
IBM Filing Assistant Version 1
IBM Graphing Assistant Version 1
IBM Local Area Network PrintManager*
IBM Personal Telephone Manager Program
IBM Personal Telephone Manager Program for the IBM Personal Computer Voice Communication Option**
IBM Planning Assistant Version 1
IBM Reporting Assistant Version 1
IBM Writing Assistant Version 1
IBM 3101 Emulation Version 1
Macro Assembler Version 2
Multiplan Version 1.1

Office Correspondence Retrieval System (OCRS) Version 1
Pascal Compiler Version 2
Personal Editor Version 1
Plotting System Version 1
Professional Editor Version 1
Professional FORTRAN Compiler Version 1
Script/PC Version 1
Solutions Series: IBM Accounting Solutions Version 1
Solutions Series: IBM Executive Solutions Version 1
Solutions Series: IBM Home Solutions Version 1
Sort Version 1
Word Proof Version 1

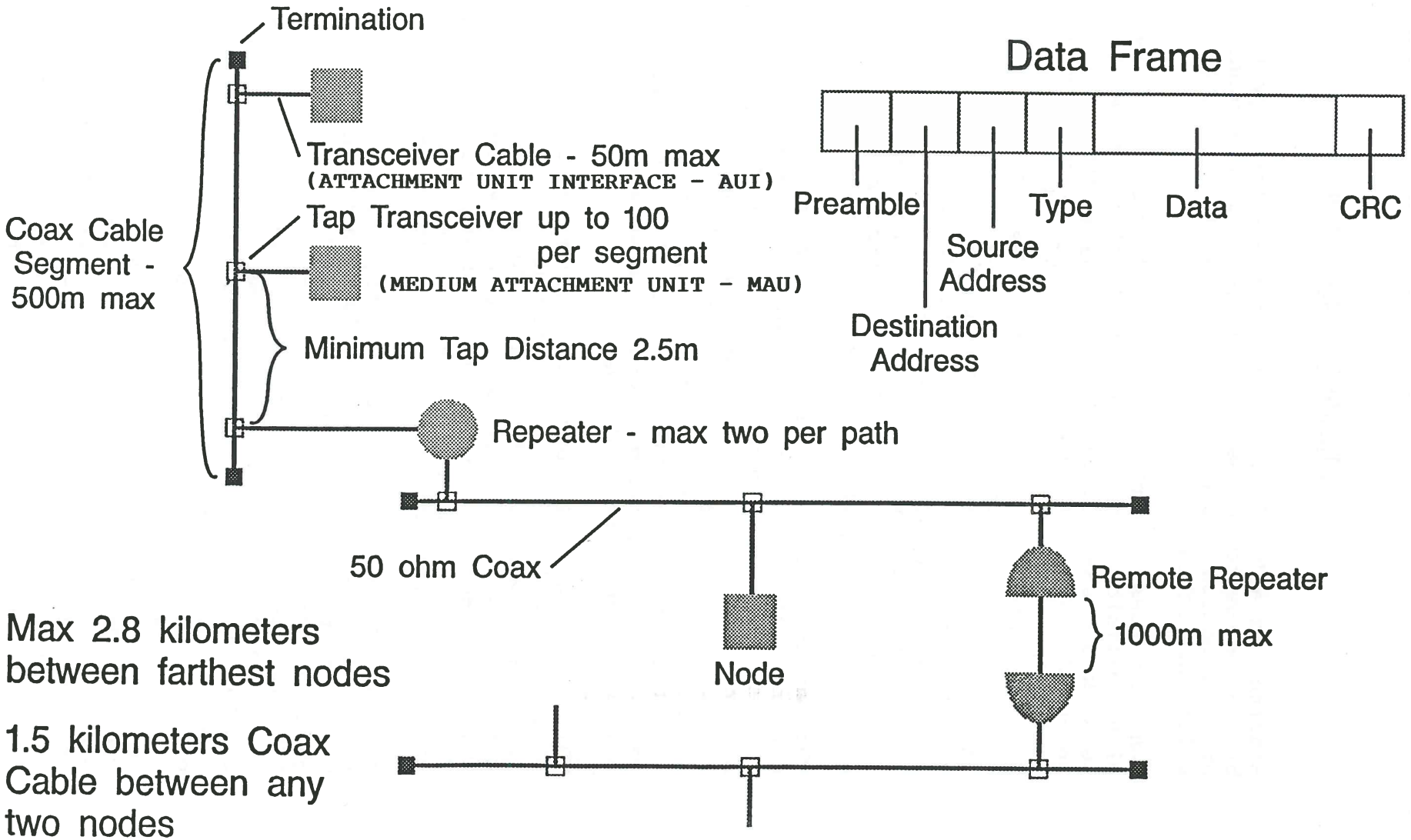
COMMAND FORMAT

COMMAND:	SUPPORTED PARAMETERS
SEND	BUFFER SIZE
	BUFFER LOCATION
	ADAPTER NUMBER
	LOGICAL SESSION #

NETBIOS COMMANDS

RESET
STATUS
ADD NAME
DELETE NAME
CALL
LISTEN
HANG UP
SEND
RECEIVE
SESSION STATUS
SEND DATAGRAM
SEND BROADCAST D.G.
RECEIVE DATAGRAM
RECEIVE BROADCAST D.G.
CHAIN SEND
ADD GROUP NAME

Ethernet


Termination
Transceiver Cable - 50m max
(ATTACHMENT UNIT INTERFACE - AUI)
Tap Transceiver up to 100
per segment
(MEDIUM ATTACHMENT UNIT - MAU)
Coax Cable
Segment -
500m max
Minimum Tap Distance 2.5m
Repeater - max two per path
50 ohm Coax
Node
Remote Repeater
1000m max
Data Frame
Preamble
Source
Address
Type
Data
CRC
Destination
Address
Max 2.8 kilometers
between farthest nodes
1.5 kilometers Coax
Cable between any
two nodes

ETHERNET DESCRIPTION

Ethernet is a baseband system in a bus topology that uses a 10M bps packet-switching network designed to interconnect hundreds of high function computer workstations or nodes within 2.5 kilometers of each other.

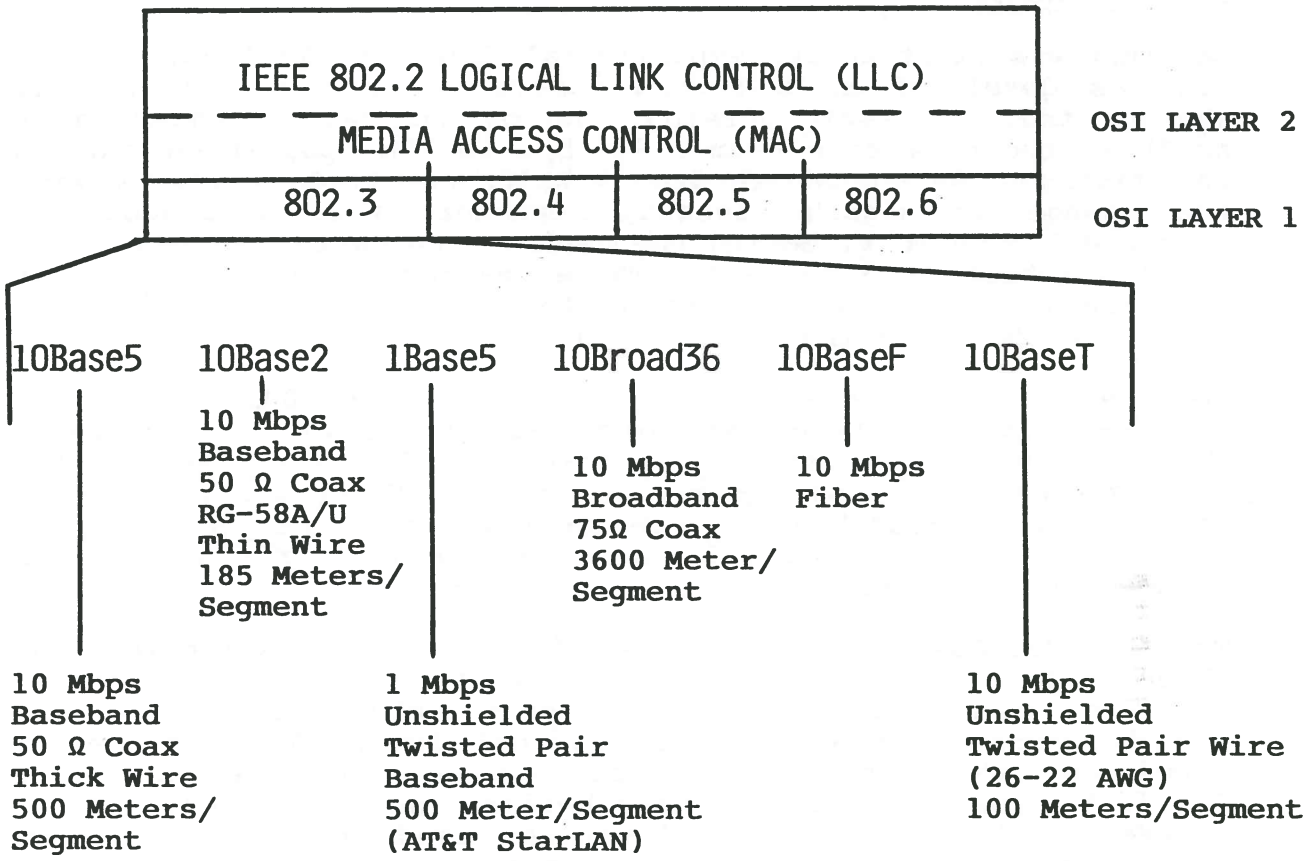
Ethernet uses a method known as Carrier-Sense Multiple Access with Collision Detection (CSMA/CD) that enables stations on the network to share access to a single coaxial cable path. The intended recipients detect incoming packets by recognizing their addresses imbedded in the packets. If two or more stations transmit packets at the same time, their signals will be intermixed on the coaxial cable. This is known as a collision. By listening while transmitting, the transceiver (transmitter/receiver device that attaches the user hardware, or node, to the cable) can detect collisions on the cable trunk. The transceiver then generates a collision signal back to the node. The node then "backs off" by waiting a certain time interval before attempting to retransmit the packet.

The physical layer, which handles the actual transmission of the data over the cable, consists of Ethernet transceivers connected to a 50 Ω coaxial trunk. Each transceiver is positioned wherever network access is required, according to certain specifications. A length of interface cable, drop cable, joins each transceiver to a controller/terminal or network interface card (NIC). The interface cable consists of four twisted pairs of wires and carries the following signals: transmit data, receive data, collision detection, and power.

When the low cost personal computer became prevalent in the office the IEEE 802 committee recognized the need for a similarly low cost network standard, thus "Thin Ethernet" was born. Thin Ethernet trades off the wide area coverage of the original or thick Ethernet for the economic advantages of using the smaller (RG58 A/U) and cheaper cable and connectors. The trade off is shorter distance and less nodes per cable segment.

Ethernet hardware consists of transceivers, NICs, and repeaters. A NIC is an adapter card installed in the DTE hardware such as a microcomputer workstation and often includes two jacks - a DB-15 jack for the thick wire network interface and a BNC jack for the thin wire interface. A jumper on the NIC board must be set for the appropriate cable type. The transceiver broadcasts the digital signal onto the cable in the proper form and shunts signals to the NIC from the cable. Transceivers are also called Medium Attachment Units (MAU) in the IEEE standards and the transceiver cable then is called the Attachment Unit Interface cable or AUI. Transceivers can generate a Collision Presence Test signal, also known as the Signal Quality Error Test signal or SQE, sometimes called the "heartbeat". This signal confirms that the collision detect circuitry in the transceiver is operational. Repeaters are used to regenerate packet signals on one trunk cable and broadcast them onto another trunk cable as a means of expanding the network's physical length, which can be achieved up to certain limits.

LAN TRANSMISSION STANDARDS



IEEE 802 PROJECT

802.1	HIGHER LAYERS AND INTERNETWORKING
802.2	LOGICAL LINK CONTROL
802.3	CSMA/CD BUS
802.4	TOKEN PASSING BUS
802.5	TOKEN PASSING RING
802.6	METROPOLITAN AREA NETWORKS (MAN)
802.7	BROADBAND TECHNOLOGY ADVISORY GROUP
802.8	OPTICAL FIBER TECHNOLOGY ADVISORY GROUP
802.9	VOICE/DATA INTEGRATION ON LANs
802.10	STANDARD FOR INTEROPERABLE LAN SECURITY

ETHERNET STANDARDS DESCRIPTION

UNDERSTANDING THE DIFFERENCE BETWEEN ETHERNET VERSION 1, VERSION 2, AND IEEE 802.3

Ethernet was first called experimental Ethernet. In 1980, version 1.0 was developed as a second generation system with several changes from the early version. One of the major changes was a shift in the data rate from 2.94M bps to 10M bps, which reduced the maximum segment length from 1 kilometer to 500 meters. With the change in segment length, repeaters were introduced to extended the network, making the maximum separation between nodes 2.5 kilometers or 5 segments. These changes also resulted in an increase of the maximum number of stations from 256 to 1024 and a change in the cable from 75 Ω to 50 Ω.

Version 2.0 was introduced in 1982, as the IEEE 802 Project got underway, by the three companies that had developed Ethernet. Version 2.0 was an attempt to resolve differences between the newly proposed standard and the established Ethernet. Version 2.0 is upwardly compatible to version 1.0 and better defines the details of physical channel signaling and by including network management functions.

The IEEE 802 Committee issued the IEEE 802.3 publication in 1985, which made a few changes in the data link layer to better interface to a variety of upper layer structures as well as some pin definition changes in the physical layer. The transceiver interface, therefore, is different between Ethernet and IEEE 802.3. The data link layer frame header also has differences. In general, older DEC Ethernet backbones used the Ethernet frame format, newer ones can use either Ethernet or 802.3 frames. Most NIC vendors support 802.3.

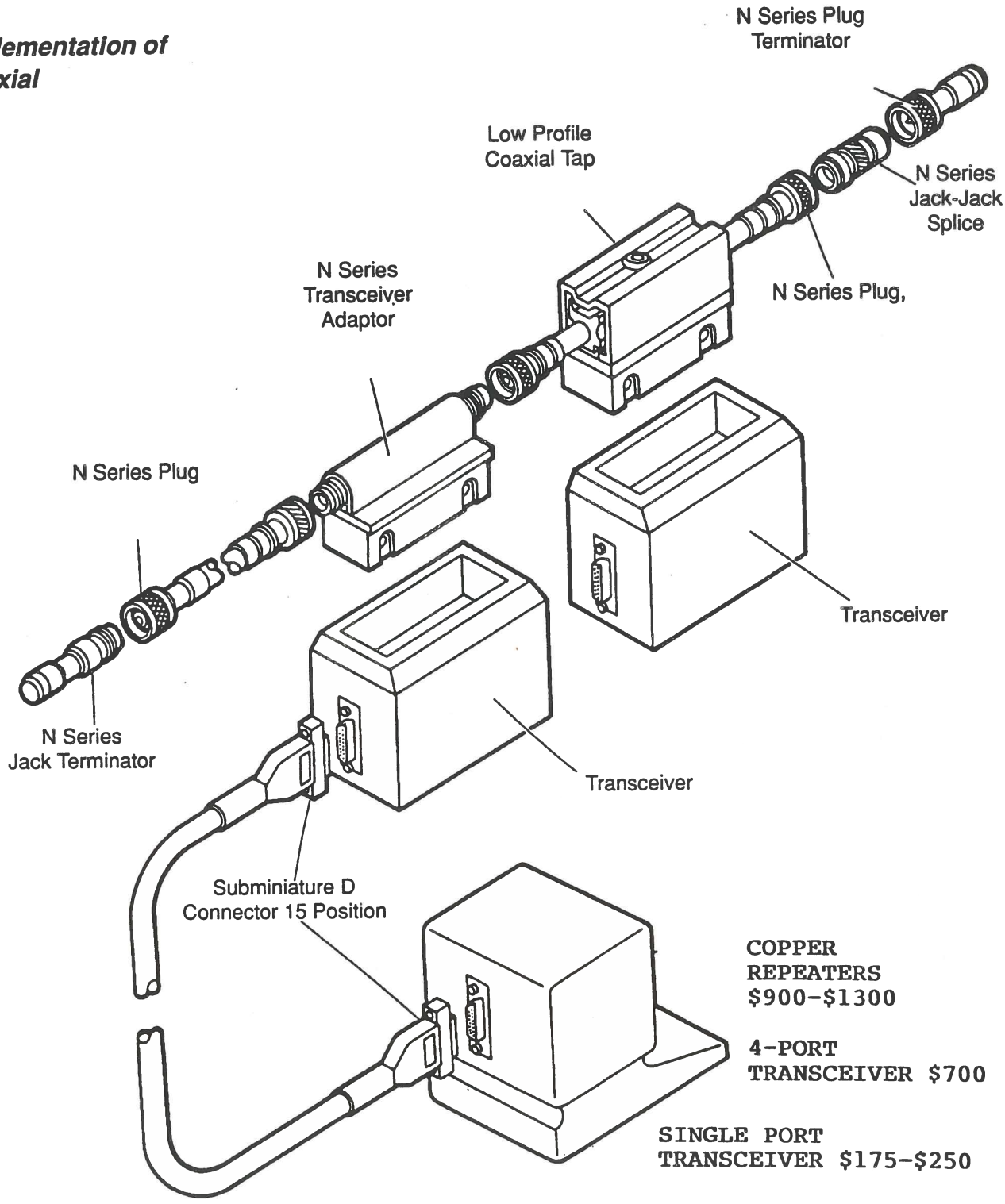
In 1988, the IEEE published the Thin Wire Ethernet 802.3 standard. This uses BNC T-Connectors to connect transceivers to the cable, which requires that the cable be cut to attach a node. Thick Ethernet used a non-intrusive "vampire" tap, which did not break the cable but only required a tap into it, somewhat like a splice. Overall area of coverage is reduced, that is the maximum distance between nodes without a repeater is 185 meters compared to thick Ethernet's 500 meters and the end-to-end network distance reduced to under 1000 meters. The number of nodes per segment was reduced to 30 from 100; however, the maximum number of nodes per network remained at 1024.

The IEEE has formalized and approved in 1990 the twisted pair version of Ethernet, called the 10BaseT standard. This is a star shaped topology compared to the traditional bus with nodes extending out from multiport repeaters a distance of up to 100 meters on 24 AWG unshielded twisted pair wire. A maximum of 5 segments can be combined for an end-to-end distance of 500 meters for the network. RJ45 telephone connectors, which support up to 8 wires, are used on the 2-pair twisted wire segment between a repeater and node transceiver.

ETHERNET AND IEEE 802 PARAMETERS

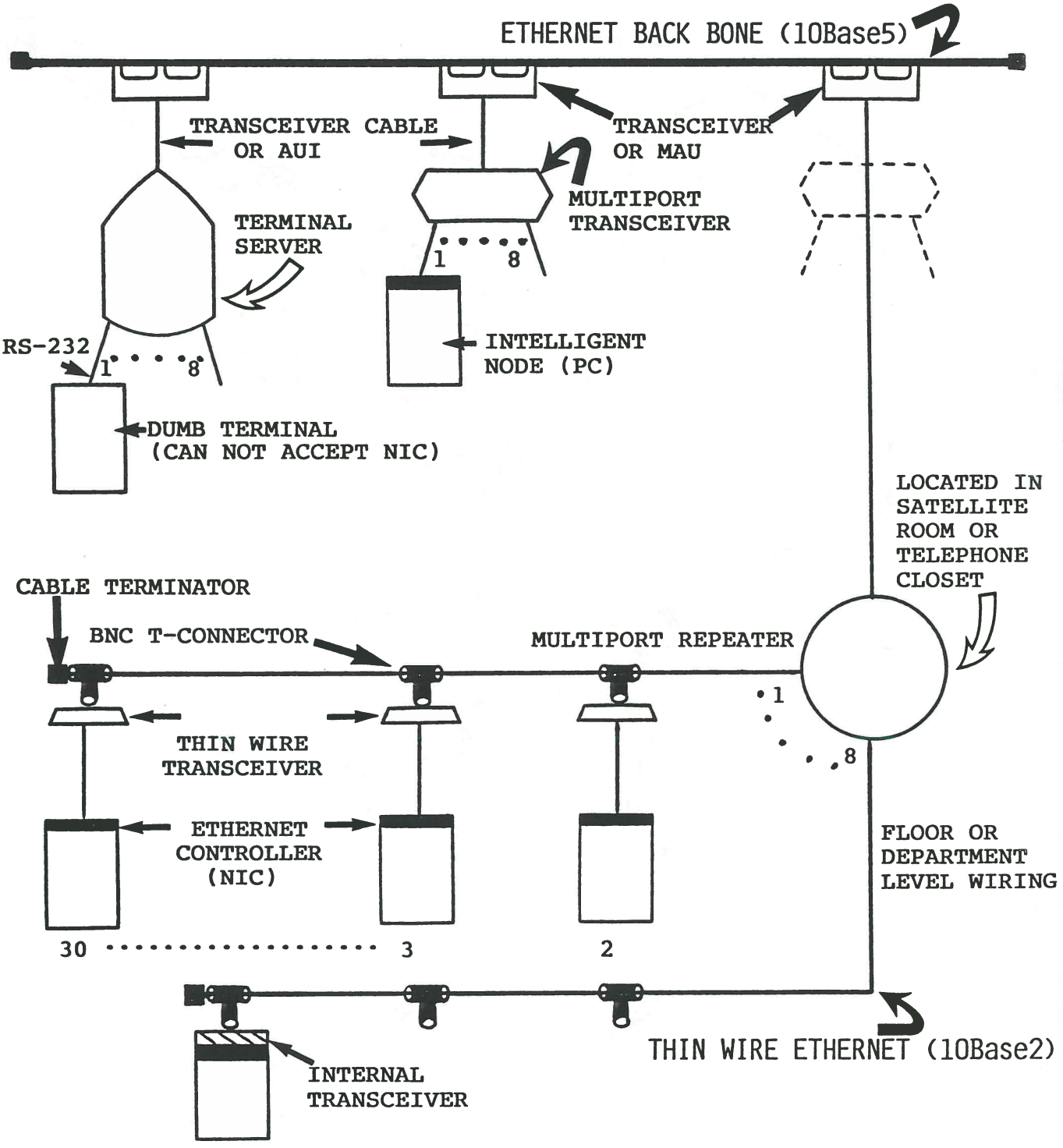
PARAMETER	ETHERNET Ver. 2.0	IEEE 802.3 10Base5	IEEE802.3 10Base2	IEEE 802.3 10BaseT
Cable Impedance	Thick Coax 50 Ω	Thick Coax 50 Ω	Thin Coax 50 Ω	UTP
Maximum Segment Length	500 m	500 m	185 m	100 m
Max Segments w/no Link Segments	3	3	3	5
Max Segments w/Link Segments	2	5	5	
Max network Span w/out Drop Cable	1500 m	2500 m	925 m	500 m
Max Number MAU/Segment	100	100	30	N/A
Min Distance Between Nodes	2.5 m	2.5 m	0.6 m	
Connector Type	N - TYPE	N - TYPE	BNC	Modular RJ45
Max Transceiver to Node Distance	Low Loss Cable - 50 m High Loss - 12.5 m (Cheaper/Flexible)		50/12.5 m IF EXTERNAL TRANSCEIVERS USED	
Transceiver	External	External	Internal OR External	
Max Nodes Per Network	1024	1024	1024	1024
Topology	Bus	Bus	Bus	Star

Implementation of Coaxial



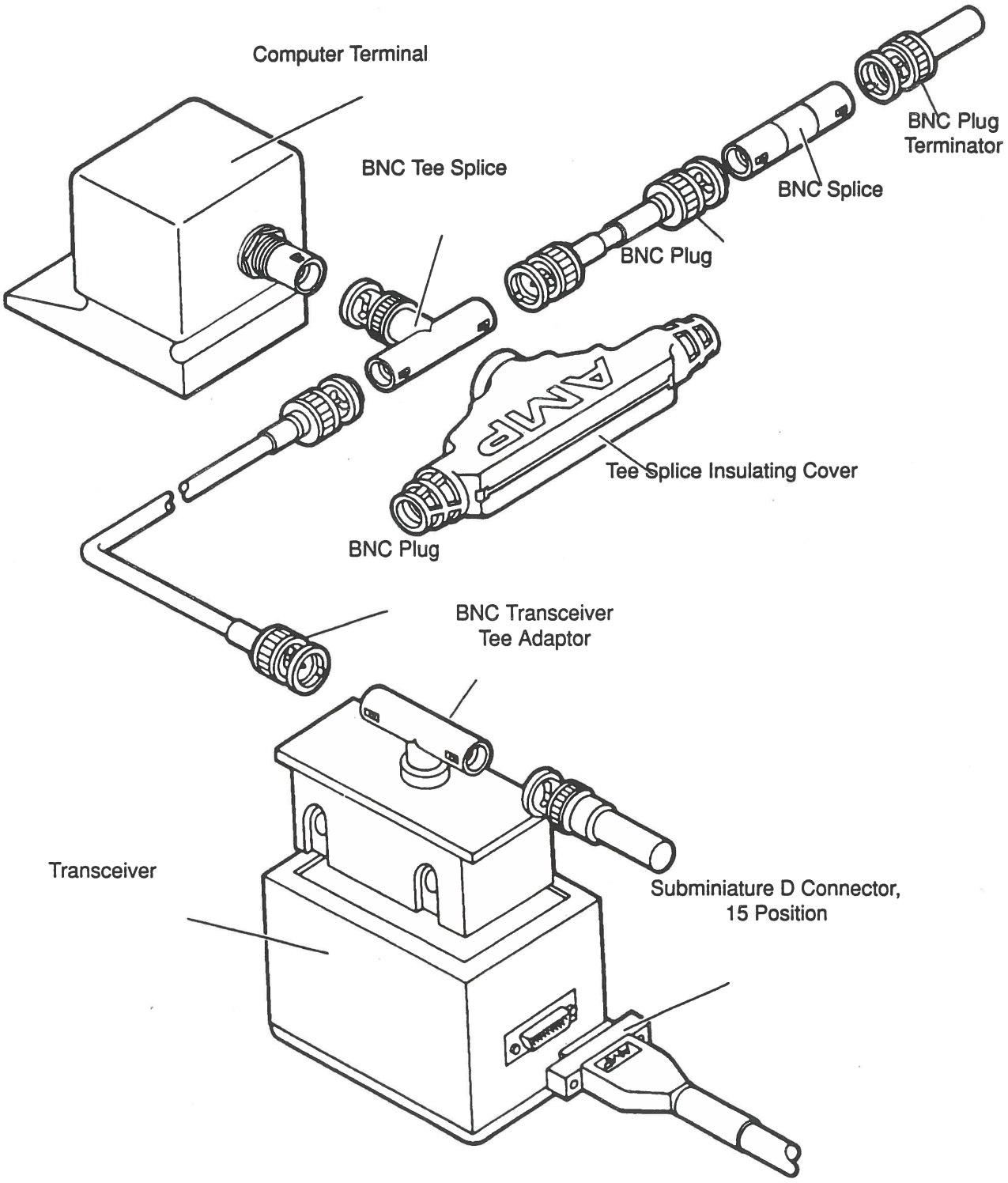
Connectors for IEEE 802.3, 10Base5
(also applies to ETHERNET systems)

COAX ETHERNET CONFIGURATIONS



TERMINAL SERVER: 8-PORT $3000
PROTOCOL PACK (EXAMPLE TCP/IP) $500

MULTIPORT/MULTIMEDIA
REPEATER: 8-PORTD
$5000 - $8000.
MANAGEMENT FEATURE: $2000



Connectors for IEEE 802.3, 10Base2

DEC ETHERNET IMPLEMENTATION

DELNI - DEC LOCAL NETWORK INTERCONNECT

MULTIPORT TRANSCEIVER CONNECTS UP TO 8 HOSTS/NODES ONTO THE CABLE WITH ONE TRANSCEIVER - NODES MUST BE LESS THAN 45 m FROM THE TRANSCEIVER. USED ALONE, WITHOUT A CABLE, IN LOCAL MODE CALLED "ETHERNET IN A CAN". CAN CASCADE DELNIs TO YIELD UP TO 64 NODES PER TRANSCEIVER BUT STILL 50 m LIMITATION.

DEMPR - DEC MULTIPORT REPEATER

MULTIPORT REPEATER THAT ALLOWS UP TO 8 THIN WIRE ETHERNET SEGMENTS TO BE CONNECTED TO THE ETHERNET BACK BONE THICK WIRE OR INTO A DELNI. IF INTO THE DELNI THAN CAN SUPPORT UP TO 232 NODES TO ONE TRANSCEIVER (8 @ 29 nodes per thin wire segment, DEMPR counts as 1 node).

DESPR - DEC SINGLE PORT REPEATER

DEREP - DEC REPEATER (BASIC)

CONNECTS TWO SEPARATE BASEBAND SSEGMENTS TOGETHER USING TWO TRANSCEIVERS AND TWO TRANSCEIVER CABLES AT 50 m EACH FOR A TOTAL DISTANCE OF 100 m BETWEEN SEGMENTS.

REMOTE REPEATERS - TWO DEREPs WITH 1000 m FIBER BETWEEN

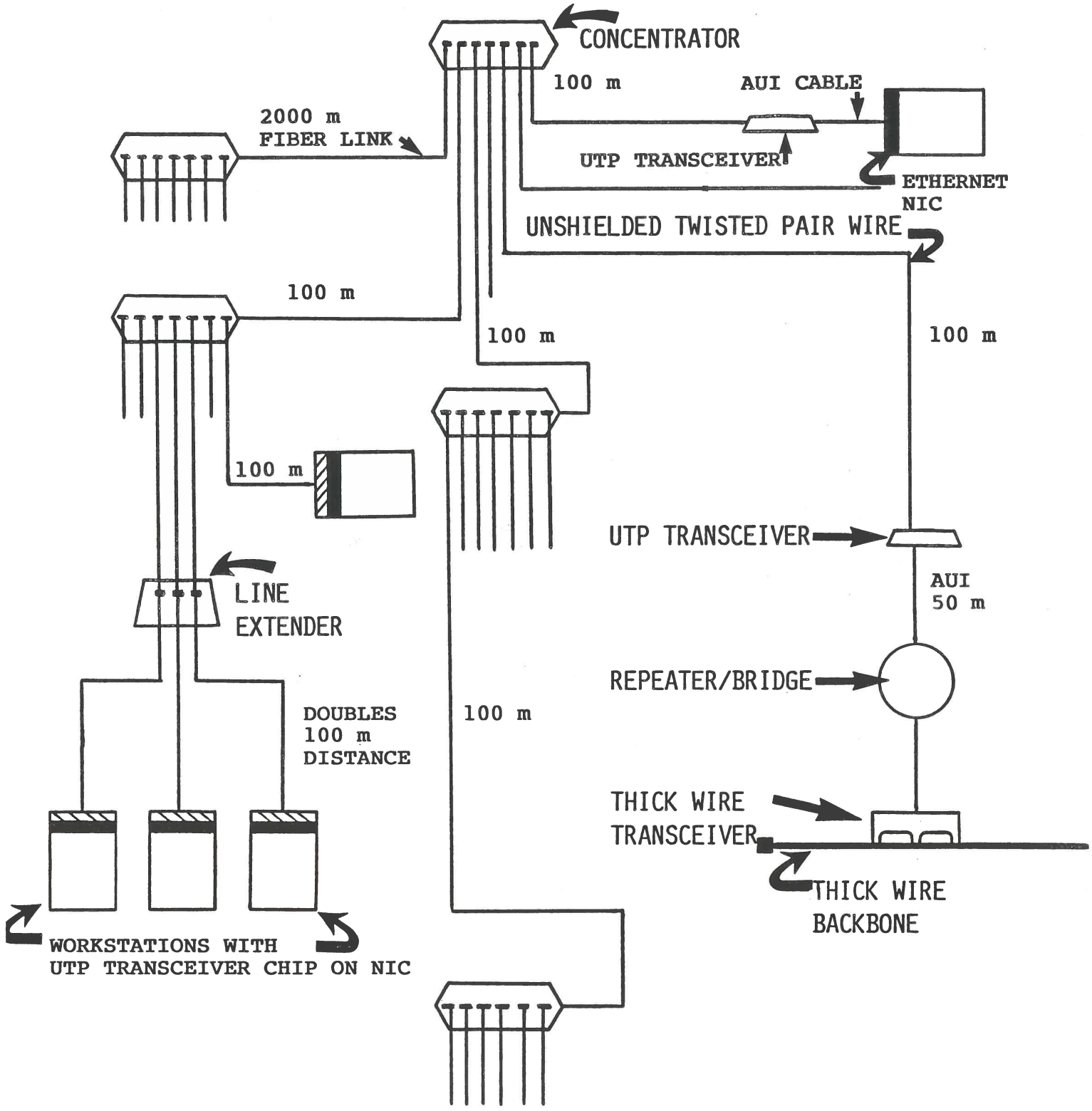
DESTA - DEC STATION ADAPTER - THIN WIRE EXTERNAL TRANSCEIVER

THE TRANSCEIVER USED ON THE THIN WIRE, RG-58 COAX (CHEAPERNET) 10Base2 VERSION. REQUIRES CUTTING INTO THE CABLE TO ATTACH THE DESTA - OFTEN PEOPLE UNPLUG DESTA, WHICH IS THE UNIT ON THE BACK OF THE COMPUTER, WHICH CAUSES AN OPEN SEGMENT.

DECserver 200, DECserver 500 - TERMINAL SERVERS

DECserver 200 IS A LOW COST TERMINAL SERVER THAT SUPPORTS THE DEC LAT PROTOCOL (THE LAT ARCHITECTURE IS A SET OF PROTOCOLS THAT ARE OPTIMIZED FOR TRANSMITTING MANY SHORT PACKETS OVER AN ETHERNET - TRANSPORT AND SESSION LAYER ONLY AS NO ROUTING REQUIRED ON ETHERNET). DECserver 200 HAS UP TO 8 RS-232 PORTS, SOME VERSIONS ALSO HAVE MODEM CONTROL ALLOWING THE TERMINAL SERVER TO TERMINATE A SESSION WHEN THE USER HANGS UP FROM A REMOTE SITE. DECserver 500 HAS UP TO 128 PORTS SUPPORTING RS-232 OR RS-433-A CONNECTIONS. IN GENERAL, TERMINAL SERVERS ALLOW DEVICES TO CONNECT TO A LAN WITHOUT EACH DEVICE HAVING A CONTROLLER CARD, WHICH IS ESPECIALLY USEFUL FOR ATTACHING OLDER TERMINAL TYPES.

TWISTED PAIR ETHERNET IMPLEMENTATION EXAMPLE



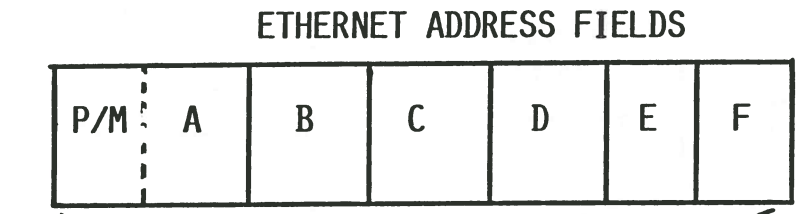
UNSHIELDED TWISTED PAIR TRANSCEIVER: $150

UTP 12-PORT CONCENTRATOR $2500

FIBER TRANSCEIVER: $600

FIBER 8-PORT REPEATER: $4000

ETHERNET FRAME FORMAT

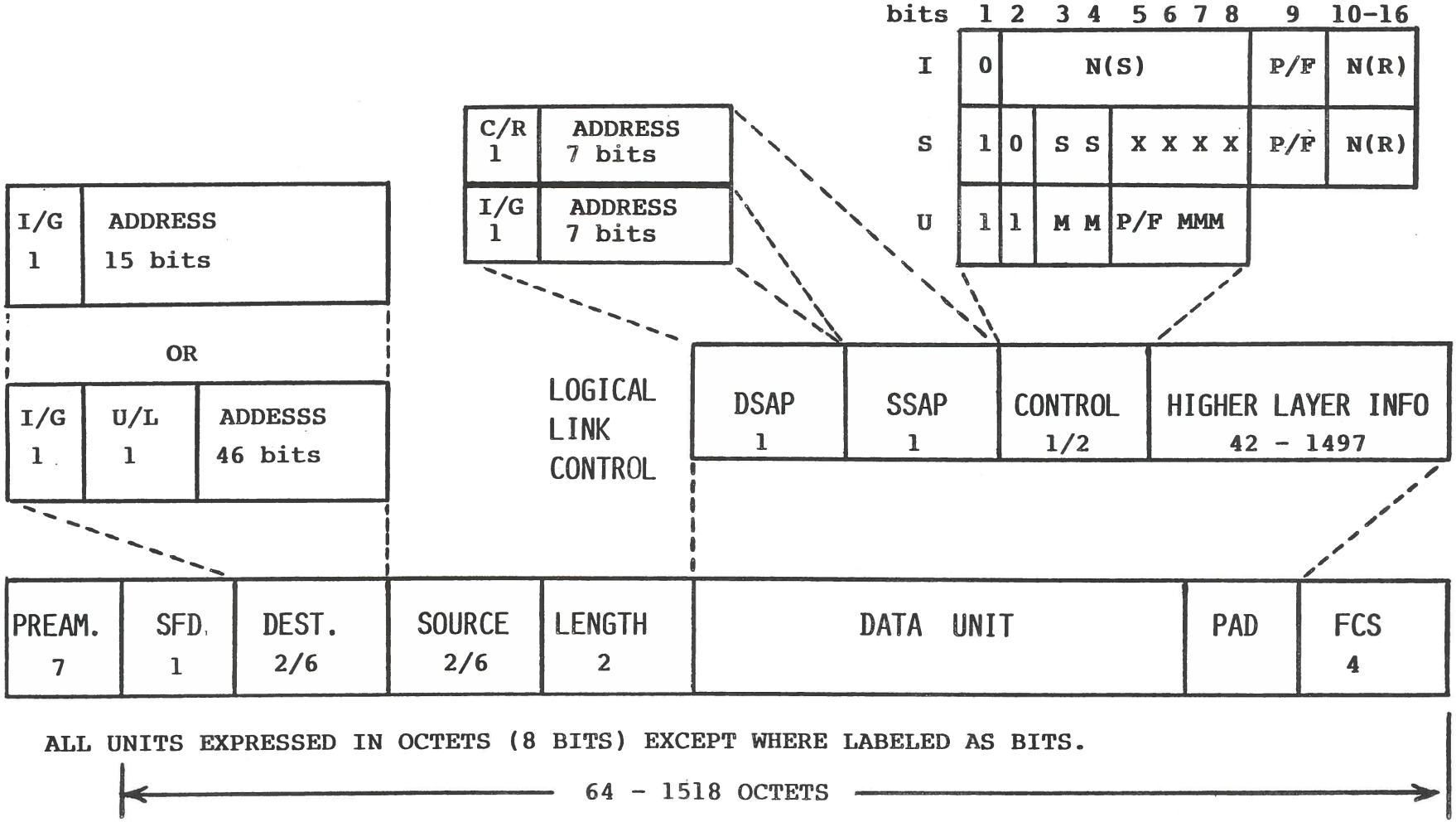


Physical addresses are subdivided with the first three octets A, B, C now administered by IEEE (formaly Xerox), and the last three octets D, E, F assigned by the network interface card manufacturer. However, the ROM containing the address can be replaced or the address reset using the diagnostic disk.

HEXIDECIMAL	DESCRIPTION
0600	Xerox XNS IDP
0800	DoD IP
0801	X.75 Internet
0802	NBS Internet
0805	X.25 Level 3
6003	DECnet Phase IV
6004	DEC LAT
6007	DEC SCA
6006	DEC Customer Use
803D	DEC Encryption
80D5	IBM SNA
8137	Novell Netware
0BAD	Banyan Systems
6010	3COM Corp.
0000-05DC	IEEE802.3 Length Field

THE IEEE 802.3 MEDIA ACCESS CONTROL FRAME

MAC FORMAT



IEEE 802.3 MAC LAYER FRAME FORMAT

The IEEE 802.2 Logical Link Control (LLC) Protocol Data Unit (PDU) contains the data and control fields from an upper layer process as well as LLC specific control fields. These include the Destination Service Address Point (DSAP), the Source Service Address Point (SSAP) and Control fields. A service address point represents the linkage between the data link layer and some specific process in the upper layers. A single physical address may support many service points running on that physical device. For example, a service point maybe an electronic mail process or a Novell Netware process. A service point process in the source communicates with a service point process in the destination. The first or least significant bit in the DSAP is an indicator as to whether it is a group or individual address, which is followed by a 7 bit service point address. The SSAP's first bit indicates whether the data in the LLC frame is a command or response. The Control field is used for network flow control and management functions under the control of the data link layer. There are three types of LLC frames that can be identified - Information type (I) which carries data, Supervisory (S) which is used for flow control, and Unnumbered (U) which is used for network management. Bit codes in the control fields indicate actions to be taken. Frame counts, N(s) and N(r), are used for keeping track of outstanding frames, and the poll/final (P/F) bit is used as an End-of-Transmission indicator.

The 802.3 Media Access Control (MAC) frame format completely encapsulates the LLC PDU. The Preamble is a 7 octet pattern of alternating 1 and 0 bits used to allow the physical signalling circuitry to reach steady-state synchronization with the received frame timing. The Start Frame Delimiter (SFD) is defined as 10101011 sequence to define the beginning of the frame. Note that in a DIX Ethernet frame the preamble field is 8 octets and has the same pattern as the 802.3 frame's preamble plus SFD fields.

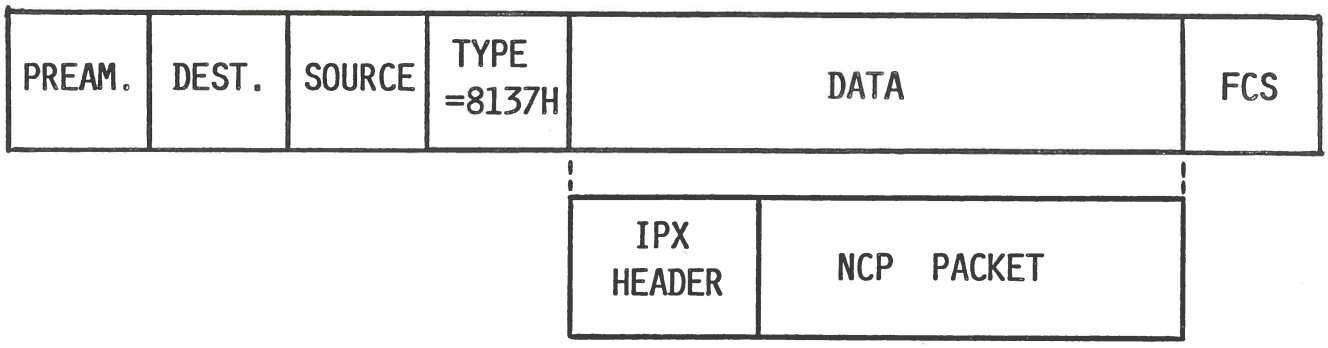
The Source and Destination fields refer to the physical unit's address, such as the NIC address. The Destination address field can be two or six octets, but usually six is used. A single bit is used to identify an individual (I) for a single or group (G) address for broadcasts destinations which is the same as the Ethernet Physical/Multicast meanings. In the Source address field, the first bit is reserved and set to zero. For 48-bit or 6 octet addresses, the second bit, (U/L), is used to distinguish between universally administered or locally (by the network administrator) administered addresses. The length of the Source and Destination fields must be set the same.

The Length field is two octets and indicates the number of octets in the data field. If the number is less than the minimum required for proper operation, a PAD will be added. After the data field comes the frame Check Sequence which is a 32-bit CRC computed on the bits from the Destination to the PAD fields inclusive.

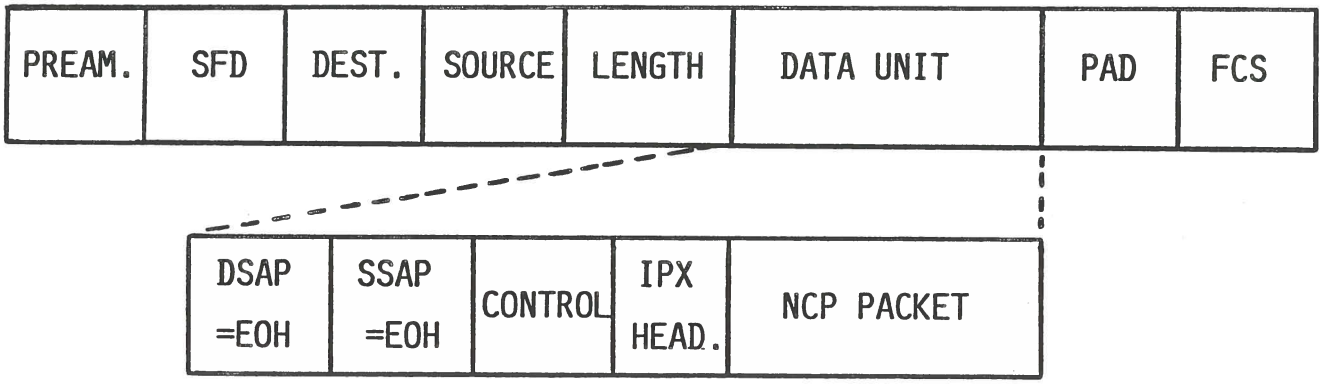
For the Data field, full data transparency is provided so that any arbitrary sequence of octet values may occur.

IMPLEMENTATION OF NOVELL'S UPPER LAYERS

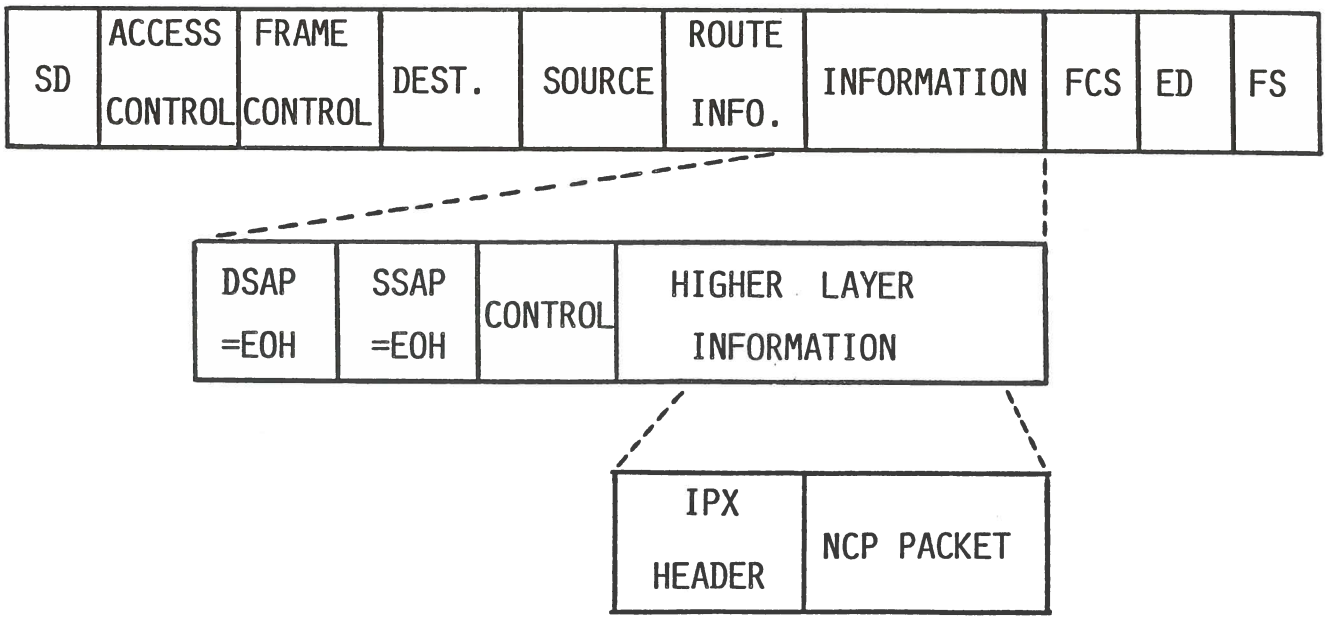
ETHERNET FRAME



IEEE 802.3 FRAME



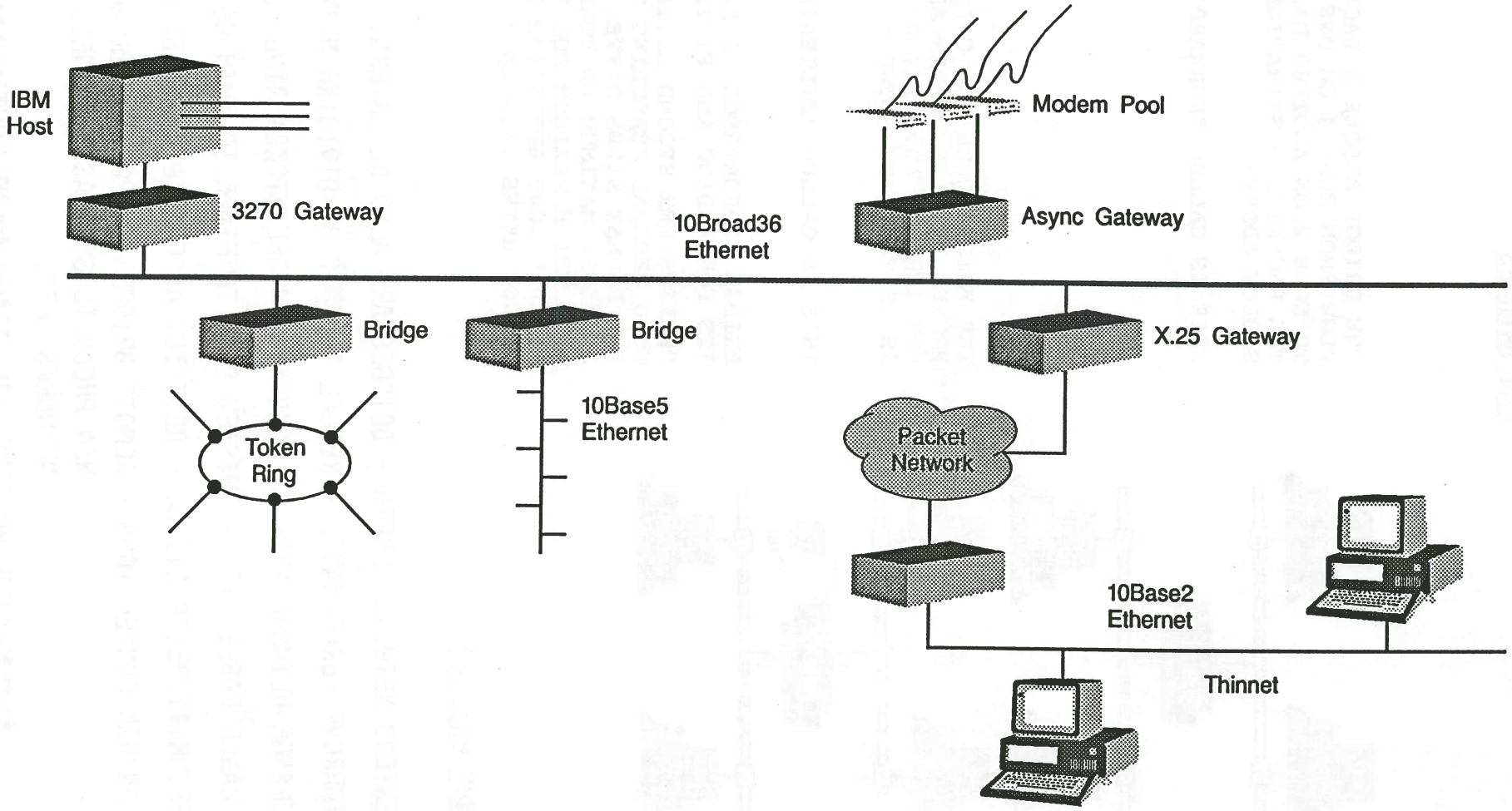
IEEE 802.5 FRAME



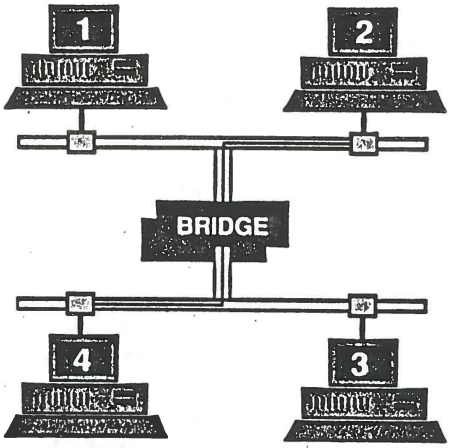
SECTION 7.0

LINKING LANS

Internetworking

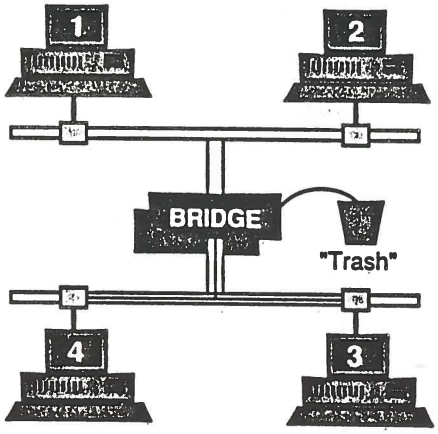


LAN BRIDGES



THE BRIDGE ALLOWS A PACKET TO FLOW FROM NODE 4 ON ONE LAN TO NODE 2 ON ANOTHER BASED ON THE PACKET'S DESTINATION AND SOURCE ADDRESS.

THIS IS CALLED "FORWARDING".



THE BRIDGE DOES NOT COPY THE PACKET BUT IGNORES IT AS THE DESTINATION ADDRESS, NODE 3, IS ON THE SAME NETWORK.

THIS IS CALLED "FILTERING".

BRIDGE PERFORMANCE IS BASED UPON ITS FORWARDING AND FILTERING RATES

PACKETS PER SECOND RATINGS IS A GOOD GENERAL MEASURING TECHNIQUE BUT PACKET SIZES DIFFER AMONG SYSTEMS. MAXIMUM ON ETHERNET IS 1518 WHILE MAXIMUM FOR TOKEN RING IS 5000 BYTES (4M bps) AND 17,000 BYTES (16M bps).

WHY BRIDGE?

EXTEND NETWORK LENGTH - BRIDGES ARE ALSO REPEATERS.

IMPROVE PERFORMANCE - REDUCE TRAFFIC BY DIVIDING NETWORK IN HALF.

CHANGE NETWORK TYPES - COMBINE ETHERNET/TOKEN RING, ETHERNET/STAR LAN.

CHANGE CABLE TYPE - TWISTED PAIR TO FIBER TO THIN COAX.

SECURITY/RESTRICTIONS - RESTRICT ACCESS TO A LAN BY ADDRESS.

LAN/WAN CONNECTIONS - REMOTE BRIDGES SUPPORT INTERFACES WITH WAN PRODUCTS SUCH AS T1 LINES, X.25 NETWORKS, ETC.

*****SOURCE ROUTING OR TRANSPARENT ROUTING******

BRIDGING LANS

A data link bridge is a device that connects two similar networks by taking packets from one and placing them on the other. It also repeats the signal giving it more strength like a simple repeater does. To transfer between LANs, the bridge looks at each packet to check the source and destination addresses, which is found in the MAC layer frame. Bridges do not care what is above the MAC layer, that is, what the upper layer protocols are above the OSI layer 2 definition. For example, the same bridge may connect networks running TCP/IP, DECnet, OSI, IPX, XNS, etc. However, a bridge will only pass the MAC frame and will not allow a device "speaking" TCP/IP to talk to another device "speaking" IPX. This type of added conversion must be performed by another LAN device called a Gateway.

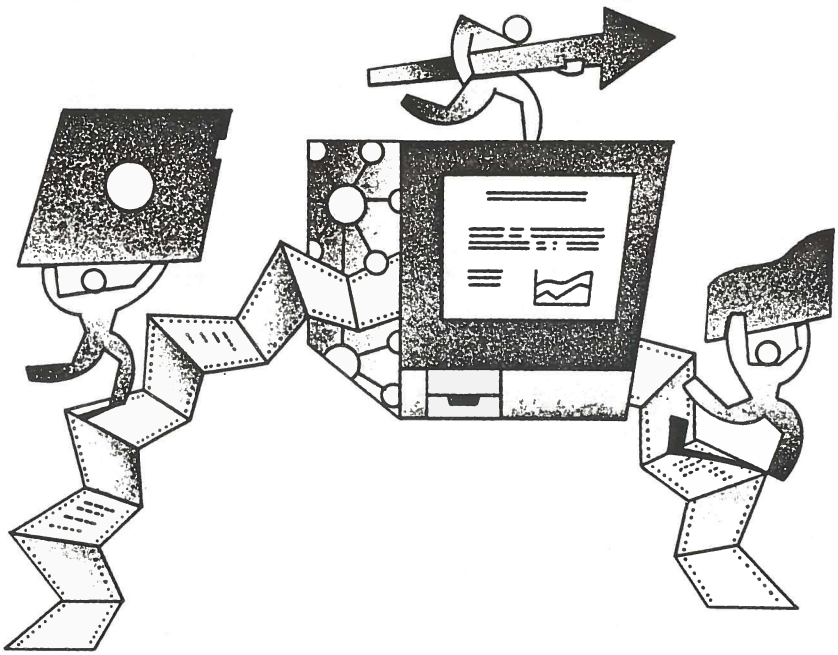
A bridge uses an address table to determine whether to pass a packet to another LAN or not. When a bridge is attached and plugged in, it begins to send out broadcasts asking for all the stations on the local segment of the network. As the stations respond, the bridge builds a table of local addresses. This process is called "learning", which is the most common type bridge. A "static" bridge is one where the LAN Manager must enter the tables. The bridge will pass packets with non-local destination addresses using this table. This is the most simple form of routing, "if it's not local than it must be for the other LAN" type.

A more advanced "filtering" technique is based upon specific source and destination addresses. For example, a bridge might stop one station from sending packets outside of its local LAN. Or a bridge may restrict packets from going to a station.

Some Token Ring bridges, from IBM, use a scheme called Source Routing to get packets between networks. This compares to Transparent Routing as described above and used by Ethernet networks. With transparent routing, the packet does not know the route it will travel, nor do the bridges. With Source Routing, the packet contains the routing information, which specifies the LANs and the bridges through which the packet will travel to its destination. The sending machine is responsible for putting this information into the MAC layer frame, next to the address fields. To determine the route, the sending stations perform route discovery whereby special packets are passed around the network. Each bridge a packet passes through puts three numbers into the packet: the number of the two LANs to which it is connected and it own bridge number. The information is passed back to the sending stations which is used to create a map of the network. This map is used to select the optimal route for transmitted packets based upon specified criteria, often defined by the LAN Manager.

LAN BRIDGE PRODUCTS

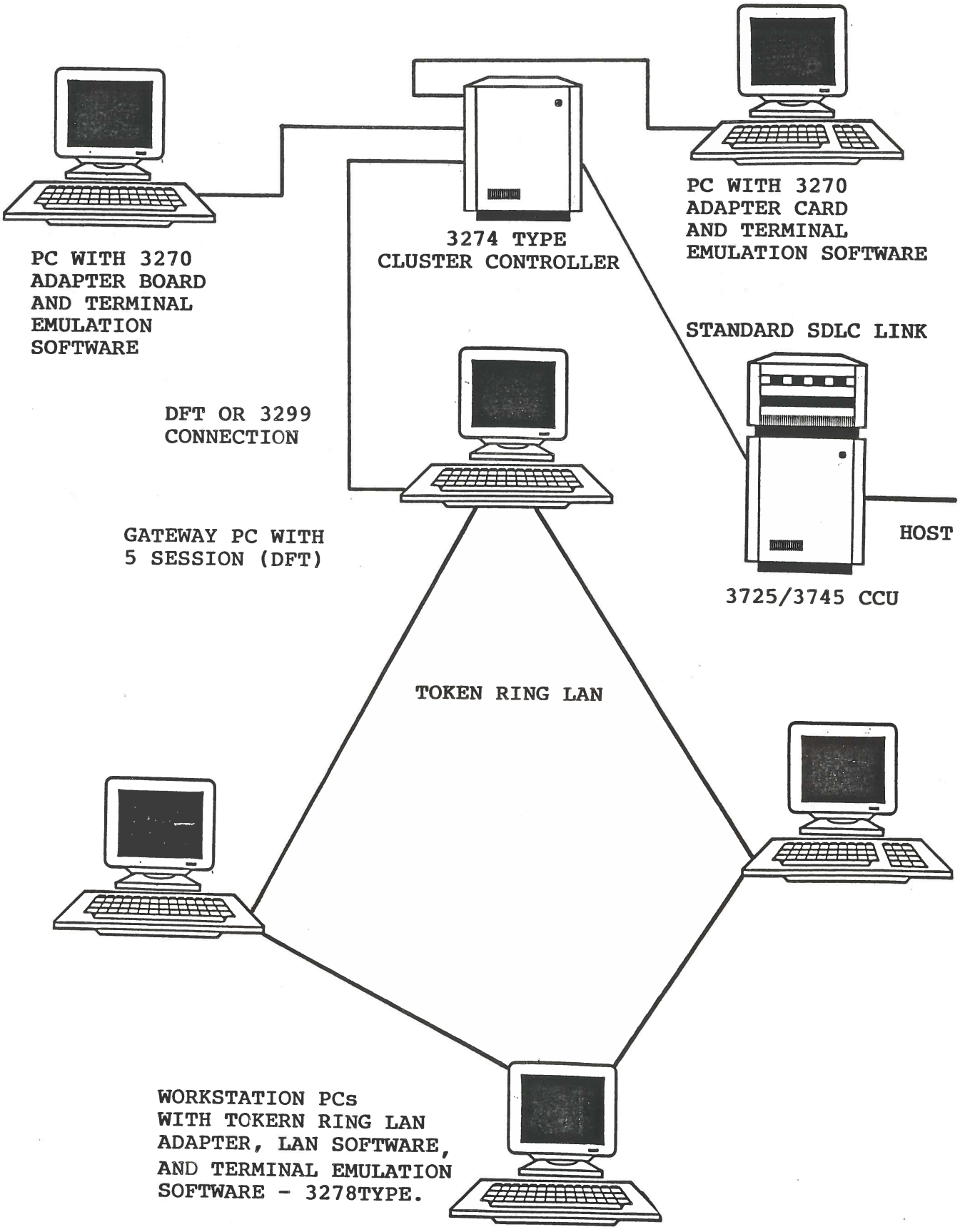
COMPANY	PRODUCT	APPROXIMATE PRICE
10Net	10Net LAN Bridge	$ 4495.00
3COM	IB1, IB2, IB3	3995.00 +
Adv. Comp. Communic.	4030 Remote Ethernet	11499.00
Alantec	MultiLAN Switch (MLS)	9800.00 +
BICC	1400 Primary Bridge	5875.00 +
Cabletron	NB20E	7500.00
Chipcom	Ethermodem III Bridge	4995.00
cisco	HyBridge	5395.00
Communic. Machinery	DRN-3100	10750.00 +
Concord	Series 4200	8950.00
Digital Equipment Co.	LAN Bridge 100	8950.00
	Metrowave Bridge	5550.00
Halley	Model 102, Model 111	8950.00
Interlan	IB10, IB30	10800.00 +
Lanex	MAC8023 MAC-layer Bridge	3995.00
Microcom	LAN Bridge	5499.00 +
RAD Network Devices	Remote Ethernet Bridge	4950.00 +
Raycom	Bridge+, Bridge+1.5	1580.00 +
Retix	Model 2244 Bridge	3995.00
Sytek	8011, 8050, 8080, 8220	2995.00 +
TRW	NB2000	9950.00
Ungermann-Bass	Net/One Data Link Bridge	6200.00 +
Vitalink	TransLAN	9995.00 +
Wellfleet	Concentrator Node, Link	2295.00



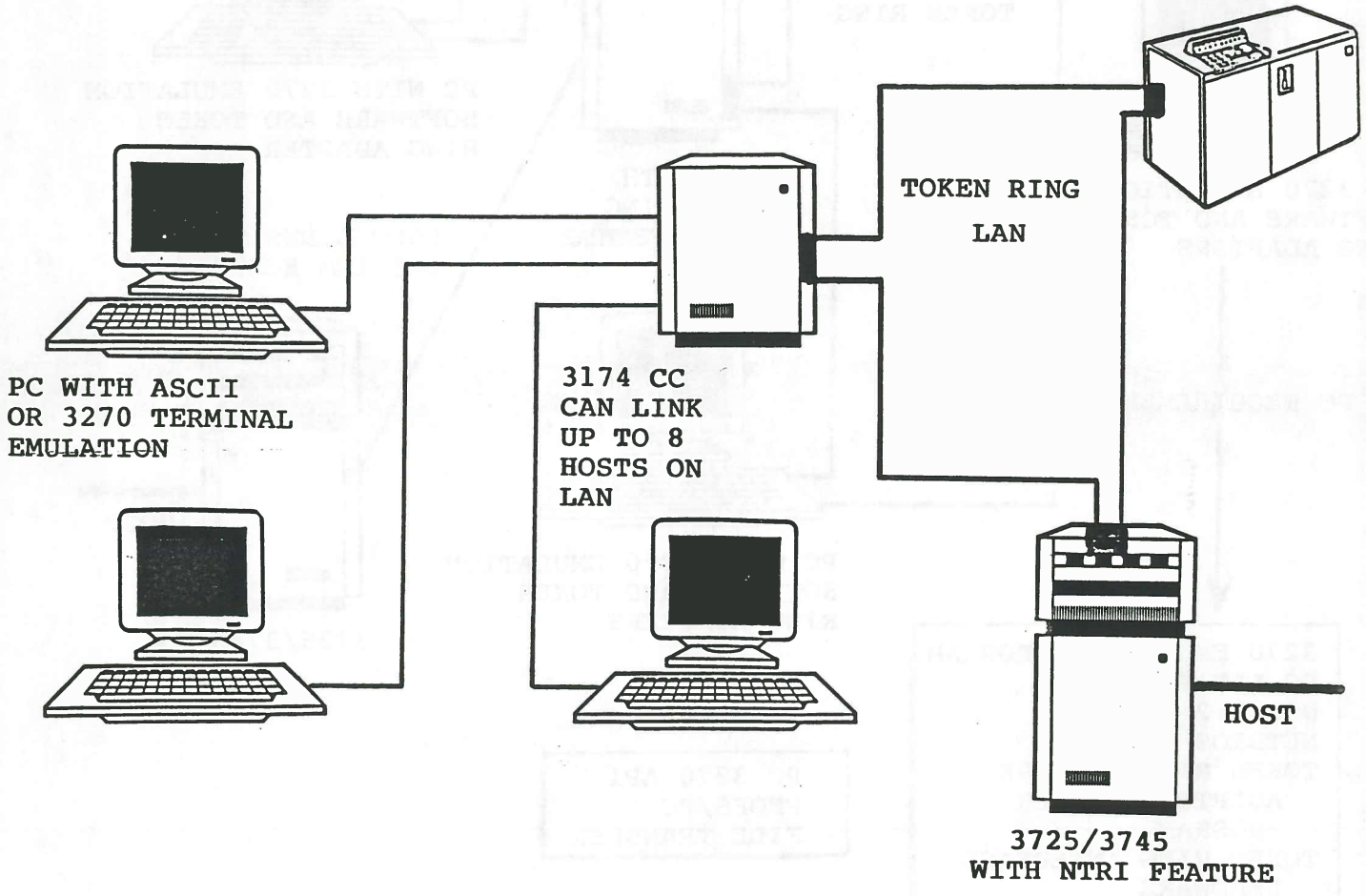
COMPARISON OF INTERNETWORKING SYSTEMS SOLUTIONS

	Advantages	Disadvantages
BRIDGES	° are simple to install ° require no configuration ° can connect different high-level protocols ° are flexible and adaptable ° provide network management functions ° offer very good price performance	° can constrain internetwork topology ° introduce dealay that can limit the size of internetworks ° offer little support for fault isolation ° may prevent certain applications from running over internetworks
ROUTERS	° are extremely configurable ° are easy to maintain once they are installed ° provide protective firewall between interconnected segments ° are not subject to time-delay constraints ° permit the presence of active loops	° can require extensive initial configuration ° are protocol dependent ° cannot route low-level protocols ° are more expensive than bridges to purchase
MULTI PROTOCOL ROUTERS	° offer all the advantages of routers ° accommodate several protocols	° have all the disadvantages of routers
BROUTERS	° offer all the advantages of bridges and routers ° offer the flexibility of bridging, routing, or both concurrently	° are most complex to install

3274 CONTROLLER LAN GATEWAY



IBM 3174 AND IBM 3725/3745 TOKEN RING INTERFACE

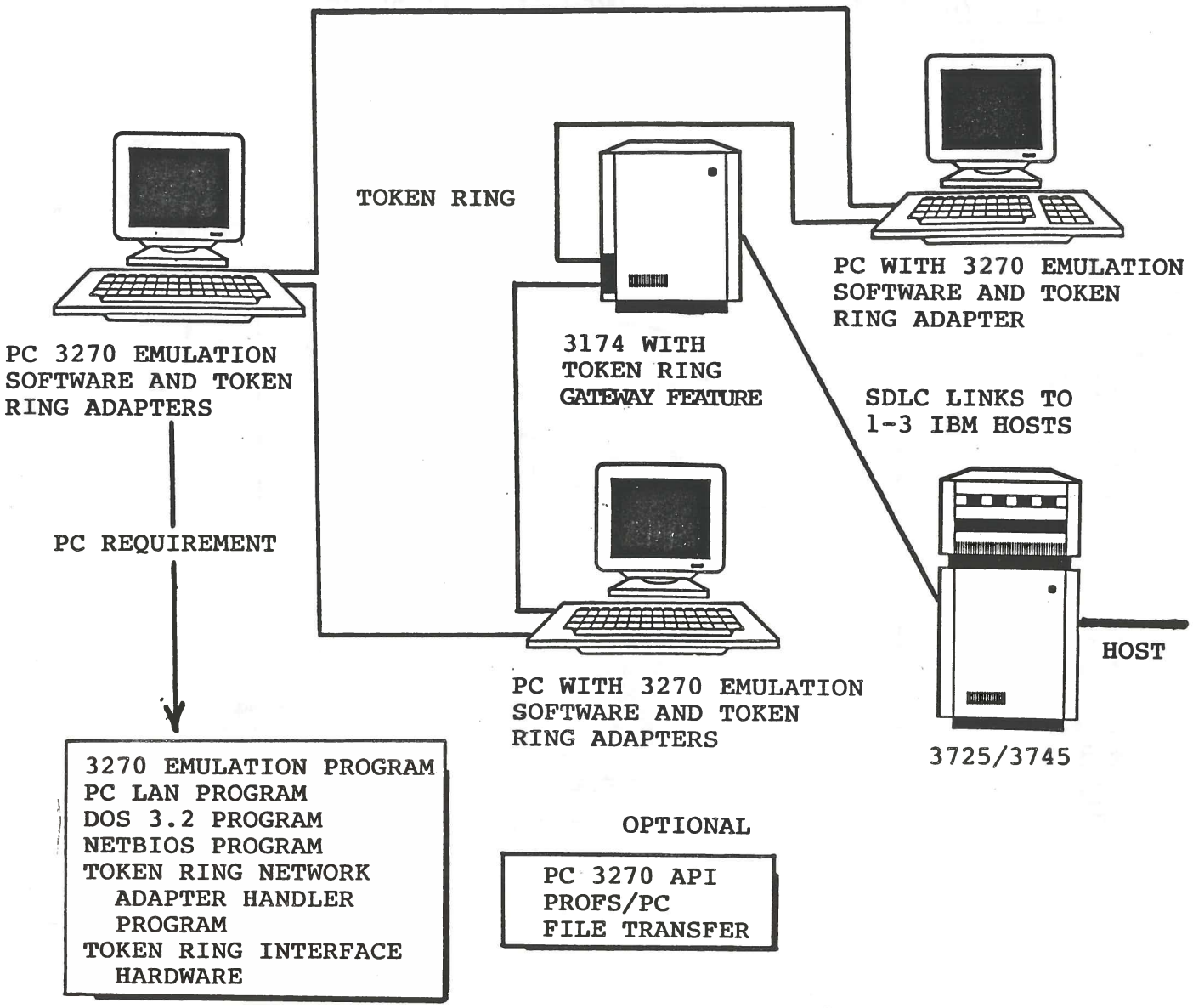


THE TOKEN RING INTERFACE COUPLER IS A HARDWARE INTERFACE TO THE TOKEN RING LAN FOR THE 3174 and 3725/3745 UNITS. THIS IS A PHYSICAL AND DATA LINK LAYER INTERFACE THAT REQUIRES OTHER LAYERS TO BE PRESENT IN EITHER THE 3174 CLUSTER CONTROLLER OR THE ATTACHED PC. IF THE PCs ARE USING SIMPLE ASYNC TERMINAL EMULATION THEN THE 3174 MUST BE CONVERTING THE PROTOCOL TO STANDARD 3270 LU TYPES.

THE 3174 CAN COMMUNICATE WITH UP TO EIGHT HOSTS ON THE LAN AT ONCE.

THE NCP TOKEN RING INTERFACE IS INSTALLED AS PART OF ACF/NCP AND PROVIDES SUPPORT FOR THE TOKEN RING ATTACHMENT OF THE 37X5.

IBM 3174 AS LAN GATEWAY



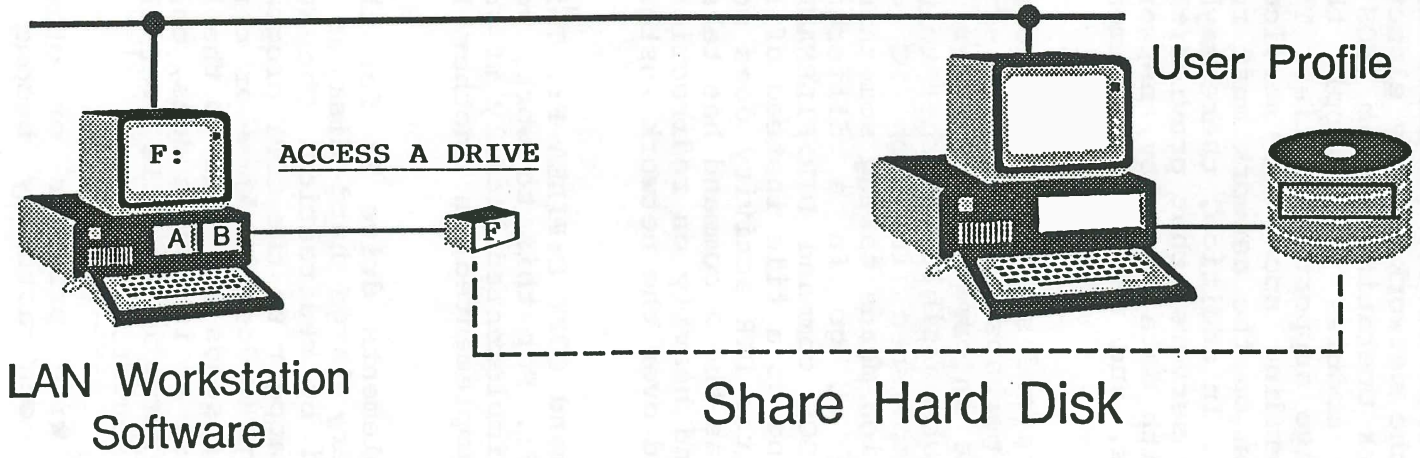
THE 3174 CAN ACT AS A GATEWAY FOR PCs ON A TOKEN RING LAN TO SDLC HOSTS. USING THE 3270 EMULATION SOFTWARE, THE PCs CAN COMMUNICATE AS 3278 TYPE TERMINALS WITH TYPICAL CICS INTERACTIVE APPLICATIONS. THE 3174 CAN ALSO CONNECT WITH UP TO THREE IBM HOSTS OVER TELEPROCESSING LINES OR ON AN I/O CHANNEL.

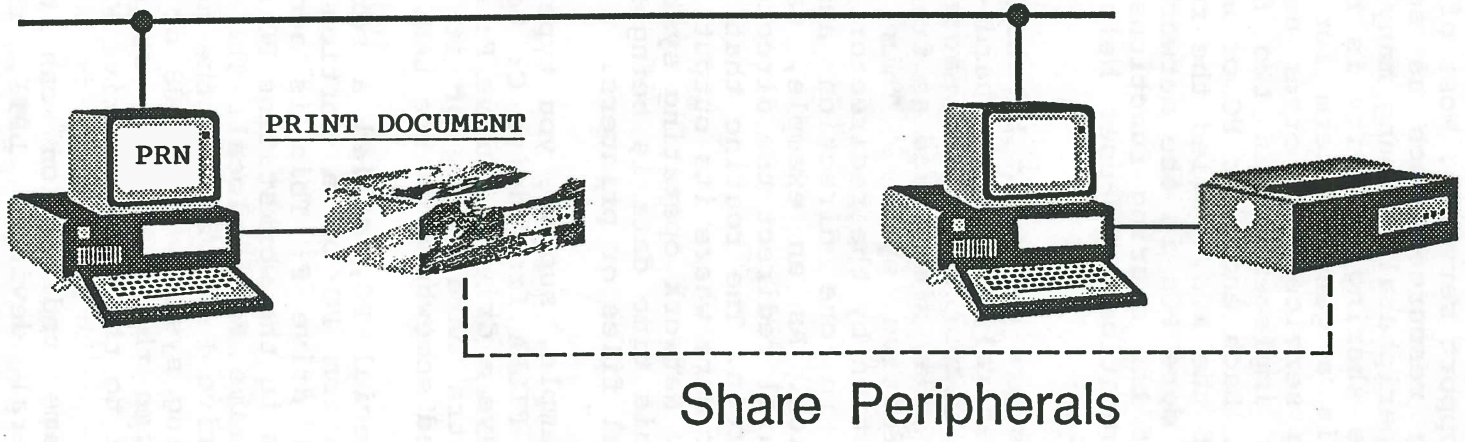
THE 3174 REQUIRES A SPECIAL TOKEN RING GATEWAY FEATURE IN ORDER TO INTERFACE WITH DOWNSTREAM DEVICES. THE PCs REQUIRE THE PC LAN PROGRAM TO COMMUNICATE ON THE LAN.

SECTION 8.0

LAN OPERATING SYSTEMS

PC LAN Operations





NETWORK OPERATING SYSTEM - THE REDIRECTOR

Personal computer networks use the 802.X technologies to deliver information packets to devices, personal computers in most cases, but additional software and hardware are needed to provide end user support services. Most of these additional functions involve sharing resources such as software, data files, printers and other peripherals amoung many PCs on the network. A key element in this sharing activity is the Network Operating System (NOS), which is a general term for software modules that supply the sharing services and other network usage support utilities. The NOS is implemented in two forms depending upon the services needed. Each end user PC or workstation on the network must run part of the NOS, called the redirector. In addition, there maybe one or more PCs in the network, called servers, that provide the bulk of the sharing functions along with data security, network administration, end-user help routines, and network management support.

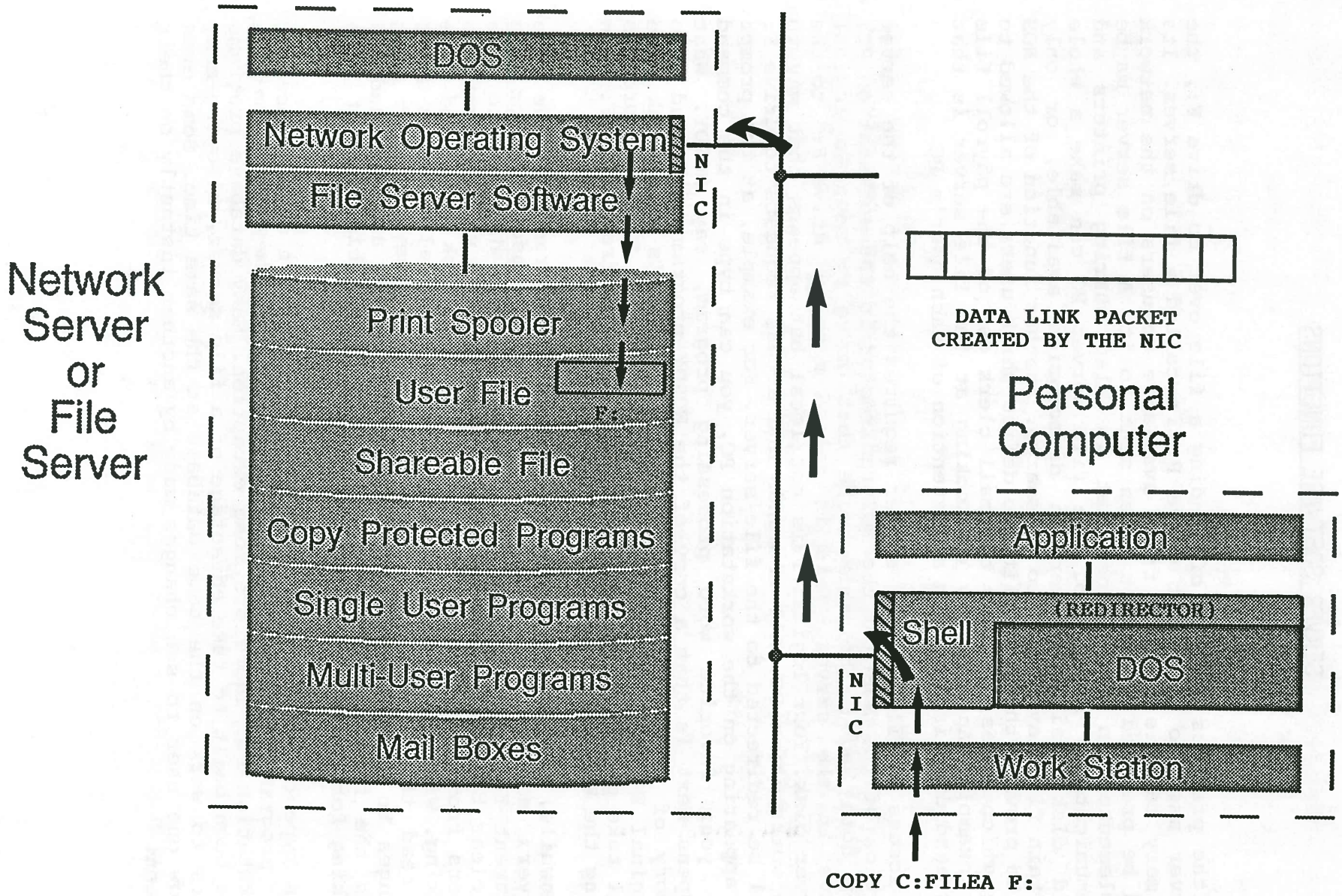
PC LANs are efficient because most data and software are stored on a centralized, large hard disk (or perhaps a few hard disks) in the network. However, access to the information or programs should be as simple and as transparent as possible in order to be an effective system. This is accomplished in each PC or workstation by the redirector. Redirection means taking something headed in one direction and making it go in a different direction. As an example, take the DOS command DIR>FILENAME, which will redirect the directory listing to a file instead of to the screen. The routine that performs the DIR activity does not know or care where its output is going as the > command has taken charge. Network operating systems depend heavily on redirection, only this time data is being redirected over the network instead to local files or printers.

For example, suppose you type the command COPY C:FILEA F:. This copies FILEA from drive C: to drive F:. For this to work, you must have a drive F: Drive F: could be implemented locally if you had extra hard disks or it can be implemented on another PC attached somewhere on the LAN.

The special PC, called a server, implements drive F: for the workstation PC on a portion of a very large hard disk as a logical drive F: This is accomplished by redirection. The NOS program in the workstation PC makes it appear to the COPY program that drive F: is local. The COPY program doesn't know or care that drive F: is across the network. It sends the file to the PC operating system, like DOS or OS/2, just as it always does, only this time the redirector steps in to reroute the file over the network to the logical drive F: in the server.

The same redirection can be done with printers or other peripheral devices. LPT1, therefore, can actually become a printer somewhere else on the network.

Microcomputer LAN Software



SERVER SOFTWARE FUNCTIONS

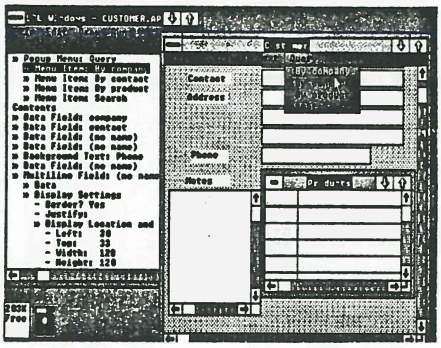
In the previous example of sending a file over to drive F:, the server used to implement drive F: is called a file server. Its primary task is to make files available to users on the network and be prepared to accept files sent to it. A file server maybe implemented in a machine that is also sharing printers and communications lines too. The file server PC can make a whole hard disk available, certain directories available, or only certain files available to be shared. Another function of the NOS is to provide the capability to define which users are allowed to use which files, keeping the mail clerk out of the payroll file for example. Another way of looking at the file server is that its hard disk is becoming an extention of each user's PC.

To access a file on the server requires the help of the server portion of the NOS and the NOS redirector in the workstation PC. They both had to be made aware that drive F: means a logical drive in the server. This is called mapping drive F: to the server disk. Your logical F:is not local but appears that way to the workstation PC. All commands and access requests to drive F: will be redirected to the file server. For example, at the prompt F: appearing on the workstation PC, you can type in the command for your favorite word processing program, say WORDY. What happens next is that a copy of the WORDY program is loaded into memory of the workstation PC from the server's hard disk. The original WORDY program is still in the server. The same process will take place for the document file you open from drive F: when using the WORDY word processing program.

Meanwhile, other people can use the WORDY program from the file server, assuming you have a multiuser license. As for the document file you opened, WORDY must have been designed to make it clear to other users that it is currently in use and prevents others from using it at the same time. This task is called file locking. With some programs, file locking might allow other users to read the document you are editing but they can not make changes to it. They will have to wait until you are finished and open the file again. Some NOS will provide this kind of file locking for programs that don't.

This type of file service is simply an extension of the local PC and programs work just as they would if they were on the workstation PC. There are some exception. Many database programs have been built to take advantage of a file server, allowing many users to work on the same database at the same time. Some even allow one user to see changes made by another instantly on their screen.

COMMANDS AND UTILITIES



NETWARE UTILITIES

SYSCON - PROVIDES SYSTEM CONFIGURATION CHOICES SUCH AS TO SET UP SCRIPTS, VIEW RESTRICTIONS, GROUPS YOU BELONG TO, ETC.

FILER - FILE MAINTENANCE UTILITY TO MANIPULATE FILES, AND DIRECTORIES ON THE NETWORK, SEE FILE AND DIRECTORY INFORMATION, CHANGE VOLUMES AND DIRECTORIES.

SESSION - SESSION MANAGER, WHICH MEANS ANY DRIVE MAPPINGS, SEARCH LISTS OR GROUPS WILL BE GOOD ONLY FOR THIS SESSION OR TEMPORARY.

VOLINFO - PROVIDES INFORMATION ABOUT KILO BYTES AND DIRECTORIES CONTAINED IN VOLUMES ON THE SERVER OR LOOK AT ANOTHER SERVER'S INFORMATION.

COLORPAL - CHANGE COLORS ON SCREEN FOR MENUS

MENU - ALLOWS YOU TO SET UP A MENU DRIVEN INTERFACE TO ACCESS OTHER NETWARE UTILITIES AND APPLICATIONS WITHOUT GOING THROUGH THE COMMAND LINE PROCEDURE ON THE SCREEN.

AVAILABLE TOPICS
ACCOUNTING °
CHANGE CURRENT SERVER °
FILE SERVER INFORMATION °
GROUP INFO °
SUPERVISOR OPTIONS °
USER INFO °

NETWORK OPERATING SYSTEMS - SUMMARY 1

TYPES:

1. Low cost.
   - Support file exchange and printer sharing without use of dedicated file server.
   - Have a limit on the number of workstations.
   - Use DOS or proprietary NOS like entry level Netware.
   - Include:
     Artisoft's LANtastic
     Corvus Systems' ReadyNet
     Western Digital's ViaNet
     Novell's Netware ELS I and ELS II

2. High End.
   - Use multitasking O/S like OS/2, Unix, or proprietary systems like Netware for better performance.
   - Dedicated file server.
   - Advanced security, network management and printer sharing and superior file sharing/management.
   - Include:
     Novell's Netware line
     - Advanced Netware
     - Netware SFT
     - Netware 386 Version 3.1

     Banyan's Vines

     Microsoft/3Com Corp.'s LAN Manager which is sold to Other Equipment Manufactures (called OEMs) who add more features, such as:

     - IBM's OS/2 LAN Server
     - 3Com's 3+Open
     - Torus Systems' Tapestry II LAN Manager
     - 10Net Communications' 10NET Plus

   - Peer-based networks allow client PCs to use the resources of other clients. For example, in LAN Manager 2.0, any OS/2 1.2 workstation can be accessed by other DOS and OS/2 clients. A workstation can thus be used as an alternative server.
   - Internetworking/bridged networks require strong naming schemes (global naming) allow users the ability to reference resources on other local networks without being logged on to them and know about them. Banyan Vines has one of the best naming service but others are closing the gap.

NETWORK OPERATING SYSTEMS - SUMMARY 2

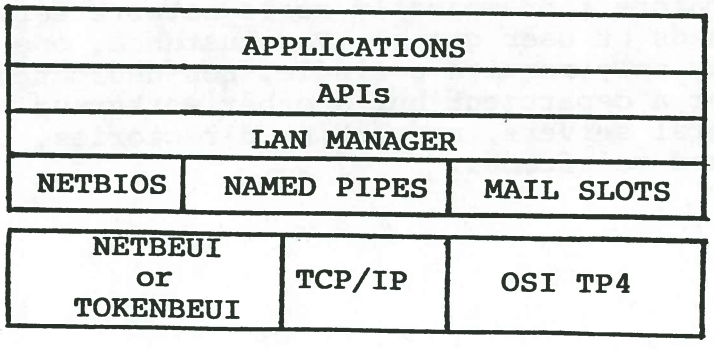
MICROSOFT/3COM LAN MANAGER:

MS-Net is Microsoft's early basic network operating system for DOS based PCs "OEMed" to other vendors for added features. LAN MANAGER is also an OEM product and therefore provides a bare bones network operating system for OS/2 based machines. It provides the important services including multiuser file and print service, security, network management and a simple user interface. LAN Manager's Application Programming Interfaces (APIs) provide a rich platform upon which software developers write distributed LAN applications that take advantage of multitasking in PCs.

Like other network operating systems, LAN Manager comes in two parts, the LAN Manager Redirector, which runs in each workstation and the LAN Manager Server, which runs in the server machine. The Redirector intercepts messages from the workstations operating system or application and sends them over the network, or takes messages coming off the network and passes them to OS/2. It also provides network services such as start and stop network operations, configure a workstation's use of network resources, send messages, log errors, list servers on the network. It provides character based Windowing as the user's interface, supporting a mouse or cursor keys and pull down menus. It is compatible with the display specifications for IBM's Systems Application Architecture (SAA). There are two versions of the redirector: one for OS/2 and one for DOS systems.

The Server portion is LAN Manager's heart performing basic server functions such as file sharing, printer sharing, serial and parallel port sharing, scheduling, remote administration, central log on validation, security, receiving messages from the redirector, etc. It runs as an application of OS/2 and uses OS/2 to get the job done.

LAN Manager extends OS/2's virtual device support, multitasking and interprocess communications allowing practically everything done on a local OS/2 PC to be done remotely and it appears transparently to the user, such as file/directory access or printing. The NET RUN command enables workstations to execute programs that sit on remote machines. For example, NET RUN DIR issued by another machine causes this machine to execute a directory command. Users can offload compiles, backups, etc.



NETWORK OPERATING SYSTEMS - SUMMARY 4

IBM'S OS/2 LAN SERVER:

- Based on Microsoft's LAN Manager, has two parts. The LAN Requester and LAN Server.

- LAN Requester is the workstation component, like the Redirector, and operates over Ethernet DIX 2.0, IEEE 802.3, Token Ring and PC Network (IBM's early version of a LAN). When "attached" to the OS/2 LAN Server 1.2, the LAN Requester provides access to shared network resources and processing capabilities. LAN Requester allows OS/2 workstations to use the NetBIOS protocol for LAN Server based file and print services and to take advantage of any server based application using NetBIOS.

- IBM had supported DOS workstations from the server in LAN Server 1.0, but users had to but the PC-LAN Program 1.3 for each workstation. Now with DOS Requester portion in LAN Server 1.2, those PCs can use the OS/2 servers as file servers. However, to access LAN Server 1.2 from the older PC Network, users must have a LAN Server 1.0 somewhere on the network and log on to that first and attach to the resources on the LAN Server 1.2 machine.

- LAN Server 1.2 supports 8,000 concurrent open files (using new OS/2 1.2 features), 254 simultaneous users, with up to 128 of those using DOS machines.

- A LAN Server can log on to IBM's Domain Controller and have access to resources on multiple servers. An administrator can also log into the Domain Controller and manage several servers. This is different from Microsoft's LAN Manager, the ability to manage the network from a single server on the network.

- LAN Server Domains:

  Every OS/2 LAN consists of a minimum of one domain. Domains are defined by network administrators to group server resources. This domain strategy lets administrators incrementally scale network services to the needs of user groups. For instance, one domain may only require a single, non-dedicated server for a department but another workgroup may need several servers, supporting directories, printers, modems, and mainframes.

NETWORK OPERATING SYSTEM - SUMMARY 3

MICROSOFT LAN MANAGER 1.0:

- Included security and network administration tools along with OS/2 features.
- Supports Named Pipes and NetBIOS
- Modular design of adapter card drivers and protocol stacks allowing users to run multiple protocol stacks (different sets of layers 1-4 in the OSI model sense) on different adapter cards without requiring a separate driver for each.

MICROSOFT LAN MANAGER 1.1:

- Larger number of files
- Increased security
- OS/2 1.1 support

MICROSOFT LAN MANAGER 2.0: (Beta Test)

- Supports Intel's 386/486 processors with HPFS installed specially tuned for networks. (HPFS - High Performance File System is an OS/2 ver. 1.2 feature designed to handle huge disks and huge number of files with high performance and efficient disk usage; ideal for a network server. Supports 256 character file names with embeeded spaces and mixed characters.)
- Supports multiprocessors like Compaq's SystemPro.
- Improved security, administrative tools, fault-tolerant features and the ability for the administrator to delegate tasks to the operators.
- File replication service which enables administrators to designate critical files for replication from one OS/2 server to another or to an OS/2 requester on a time-interval basis for backup.

NETWORK OPERATING SYSTEMS - SUMMARY 5

DOMAINS CONTINUED:

Each domain must have one server designated as the Domain Controller. The domain controller is the hub that controls all the LAN activity within a domain and must be brought up to support LAN activity. The domain controller coordinates communications between servers and requesters in the domain and makes resources available to users that log into the domain.

Access to LAN resources, beyond that granted by logging onto a domain, can be controller by the administrator on a user and group basis. Defining the information that will go into the database that defines domain resources and accessibility is the hardest part of installing OS/2 LAN Server. This parallels IBM's approach to building and defining large mainframe based networks; however, it has proved to be an important technique for the tight network control and network management offered by strict centralized control based structures such as that found in the domain concepts.

- LAN Server will provide a complete set of network statistics through its audit trail, error logs and network statistics:

  Who does what.
  What files are opend by whom.
  What loggins are made.
  How many blocks are transferred across network.
  Many others:

- LAN Server allows all communications and parameters to be set up at boot time. This means users don't have to bother making connections, just pick a selection from a menu and they are up and running. Aliases make this easier by hiding everything behind user definable and easy names.

- Unique features;

  Performance tuning for I/O heavy versus transmission heavy activity.

  Remote program execution and interprocess communictions provide good support for distributed processing.

  Excellant network management features track network activity, send alarms, monitor security, correct errors, work with the mainframe network management facility (NETVIEW), and local capabilities translate into enterprise-wide management system.

NETWORK OPERATING SYSTEM - SUMMARY 6

NOVELL'S NETWARE:

An overwhelming number of users choose the Netware environment because of its maturity, functionality, and performance. Novell has consistantly provided a solid network system, giving users a functional extension of the workstation operating system. Novell has over 50% of the LAN NOS market and continues to adapt to new technologies and techniques developed by other vendors, specifically, IBM and Microsoft.

PRODUCT FAMILY:

- ELS I & II

  Entry Level System for 4 to 8 users concurrently accessing the server. No bridging.

- Advanced Netware (286 chip based)

  For departmental workgroups of up to 100 concurrent users with bridging, data protection features, resource accounting, enhanced security, performance programming tools.

- SFT Netware (286 chip based)

  System Fault Tolerant adds high-level security features to the network such as disk duplexing, disk mirroring, transaction tracking (validating the complete update to a file before making final permanent change to the file), "Hot Fix" (file writes go around bad spots on disks automatically), redundant directory (two FAT files), UPS Monitoring (if power goes out, system is brought down softly while before battery back-up power goes out too), password encryption at the server.

- Netware VMS

  Allows any Digital Equipment Corporation VAX computer under VMS (VAX O/S) to function as a network server for IBM and compatible PCs allowing PC users to share access to data, print services, and applications using standard Ethernet adapters.

- Netware 386

  Takes advantage of the speed and power of the 386/486 microprocessor's 32-bit architecture, support for up to 250 concurrent users, up to 32 terabyte server disk capacity, volumes can span 32 hard drives, 4 gigabyte single file limit, and 100,000 open files.

NETWORK OPERATING SYSTEM - SUMMARY 7

NETWARE 386 Continued:

- Netware Loadable Modules (NLM)

  Uses a software bus architecture that allows drivers to exist with the operating system as equals and are known as NLMs. NLMs are programs that are loaded and linked to the operating system to perform any of a variety of tasks beyond the core Netware O/S executive functions. These are the heart of Novell's "Open Systems" approach as anything can be supported in this manner. Extensive APIs (Application Program Interfaces or the linkages into the system for outside programs) are provided to software developers as well as application development "tool kits" for efficient coding. From this, developers create NLMs which attach to the network O/S. These support software functions as well as device drivers. For example, an SQL Server can coexist as an NLM with Novell's Server.

NETWARE PROTOCOL ENGINE

NETWARE OPERATING SYSTEM ROUTINES					
NCP	AFP	NETBIOS (SMB)	NFS	APPC	NAMED PIPES
"STREAM HEAD INTERFACE" (TRANSPORT LAYER INTERFACE)					
XNS (IPX/SPX)	APPLETALK	TCP/IP	SNA	OSI	
"STREAMS" TO LINK SUPPORT LAYER					
LINK SUPPORT LAYER (DATA LINK LAYER INTERFACE)					
ETHERNET DRIVER	ARCNET DRIVER	TOKEN RING DRIVER	LOCALTALK DRIVER	ASYNC. DRIVER	SDLC DRIVER

	GENERAL	PC LAN	MICROSOFT BASED	NOVELL BASED
7	SELECTS SERVICES AND INTERFACES APPLICATIONS	PC OPERATING SYSTEM, NETWORK OPERATING SYSTEM	DOS, OS/2 EE, LAN MANAGER, LAN SERVER, PC NETWORK PROGRAM, REQUESTER, REDIRECTOR	NETWARE, NETWARE SHELL NETWARE REQUESTER
6	CODE CONVERSION, DATA CONVERSION, AND MESSAGE PACKETIZING	FILE MANIPULATION AND TERMINAL EMULATION PROTOCOLS	SMB (OS/2) NCP (DOS) NFS (UNIX) 3270 EMULATION	NFSP
5	COORDINATED INTERACTION BETWEEN END USER APPLICATIONS	APIs, INTERPROCESS COMMUNICATIONS, LOGICAL CONNECTIONS OVER NETWORK	NETBIOS, NAMED PIPES, MAIL SLOTS, APPC, EHLLAPI, SRPI, IND$FILE	NETBIOS RPC SOCKETS EMULATOR [STREAMS]
4	END-TO-END DATA INTEGRITY AND SERVICE QUALITY, END POINT ADDRESS	DATA DELIVERY PROTOCOLS BETWEEN END POINTS ON NETWORKS	TCP, OSI TP4, XNS, APPC, NETBEUI, TOKENBEUI, LAN SUPPORT PROGRAM	SPX (OSI) (TCP)
3	ROUTING AND NETWORK INTERCONNECTION	SPECIFIC PATH AND ROUTE DEFINITION, RESOLVE ALTERNATIVE PATH OPTIONS	IP, APPC, X.25, NETBEUI, TOKENBEUI	IPX (IP)
2	TRANSFER DATA UNITS TO NEXT NODE	NETWORK ADAPTER DRIVERS, HARDWARE STANDARD INTERFACES AND NICs	802.2 MAC LAYER INTERFACE NDIS 802.3, 802.4, 802.5, ETHERNET DIX V.2.0	
1	ELECTRICAL SIGNAL TRANSMISSION ONTO MEDIA	NIC OUTPUT SIGNALS	802.3, 802.4, 802.5, ETHERNET DIX V.2.0 COAX, UTP, BROADBAND, FIBER, STP	

PC LAN AND OSI LAYER COMPARISON

LAN NETWORK OPERATING SYSTEM SELECTION

BENCHMARK TESTING:

USER PERFORMED TESTS ON VARIOUS PRODUCTS TO DETERMINE SPEED, ROBUSTNESS, AND GENERAL PERFORMANCE UNDER LOAD OR USE RESULTS FROM NATIONAL SOFTWARE TESTING LABORATORIES 800-223-7093.

1. INDEXING A DATABASE - ADDING POINTERS TO FILES AND ARRANGE.
2. TRANSACTION PROCESSING - HANDLING INQUERIES FORM WORKSTATIONS.
3. REPORTING - PRINTING LARGE FILES TO DISK.
4. FILE AND RECORD MANIPULATION - LARGE SORTS, ECT.
5. LARGE FILE TRANSMISSION OVER NETWORK.

NOS PRODUCT FEATURES COMPARISON:

COMPARE DETAILED FEATURES DESIRED WITH WHAT NOS VENDORS OFFER. USE A WEIGHT FACTOR TO RANK MOST IMPORTANT FEATURES REQUIRED.

1. SERVER PARAMETERS
2. USER ACCOUNT PERMISSIONS
3. MESSAGES AND CHATTING
4. ARCHIVAL SERVICES
5. PRINTING QUEUES
6. AUDITING
7. ALERT SERVICES
8. CONNECTIVITY
9. BRIDGING
10. FAULT TOLERANCE
11. PEER RESOURCE SHARING
12. SECURITY
13. ACCOUNTING
14. E-MAIL
15. API SUPPORT
16. BUNDLED APPLICATIONS
17. SHARE-LEVEL PERMISSIONS
18. UTILITIES
19. SUPERVISOR UTILITIES
20. PERFORMANCE MONITORING
21. NETWORK PRINTING

LAN NETWORK OPERATING SYSTEM FEATURES

SERVER PARAMETERS:	NOS VENDORS: AT&T STARGROUP 386/R3.2	BANYAN VINES/386 R/4.0	IBM OS/2 LAN SERVER	WEIGHT
MAXIMUM SIMULTANEOUS USERS PER SERVER	128	U	128	
MAXIMUM SERVER VOLUME SIZE	1.2 GB	U	13 MB	
MAXIMUM NUMBER OF VOLUMES	U	10	255	
MAXIMUM SHARED PRINTERS PER SERVER	40	10	9	
MAXIMUM SIMULTANEOUS DOS SPACE LOCK-KB		1000		
MAXIMUM OPEN FILES ON ONE SERVER		5000		
OPERATING SYSTEM SUPPORT	UNIX	UNIX BASED DOS COMPAT.	OS/2 EE	
FILE SERVER RAM REQUIRED	4-64 MB	4-16 MB	3MB w/OS	
MINIMUM WORKSTATION RAM REQUIRED	256KB	100 KB	3MB - OS/2 256K DOS	
MAXIMUM NUMBER OF CONNECTIONS / SERVER				
NETWORK ADAPTERS SUPPORTED				
ETHERNET & COMPATIBLES	YES	YES	YES	
TOKEN RING & COMPATIBLES		YES	YES	
ARCNET & COMPATIBLES		YES		
AT&T STARLAN	YES	YES		
PC NETWORK 2				

NOTES AND COMMENTS

LAN NETWORK OPERATING SYSTEM FEATURES

SERVER PARAMETERS:	NOS VENDORS: 3 COM 3+ OPEN 1.1	NOVELL SFT NETWARE 286 v2.15	NOVELL NETWARE 386 v3.0	WEIGHT
MAXIMUM SIMULTANEOUS USERS PER SERVER	1000	100	250	
MAXIMUM SERVER VOLUME SIZE	4 GB	256 MB	32 TB	
MAXIMUM NUMBER OF VOLUMES	24	32	32	
MAXIMUM SHARED PRINTERS PER SERVER	5	16	16	
MAXIMUM SIMULTANEOUS DOS SPACE LOCK-KB	64 KB	MEMORY	MEMORY	
MAXIMUM OPEN FILES ON ONE SERVER	8000	1000	100,000	
OPERATING SYSTEM SUPPORT	OS/2	PROPRIETARY	PROPRIETARY	
FILE SERVER RAM REQUIRED	4 MB	2-12 MB	2.5-7 MB	
MINIMUM WORKSTATION RAM REQUIRED	50KB DOS 2.5M OS/2	70 KB		
MAXIMUM NUMBER OF CONNECTIONS / SERVER				
MAXIMUM SINGLE FILE SIZE			4 GB	
MAXIMUM LAN DRIVERS			4	
MAXIMUM DRAM MEMORY ADDRESSABLE			4 GB	
NETWORK ADAPTERS SUPPORTED				
ETHERNET & COMPATIBLES	YES	YES	YES	
TOKEN RING & COMPATIBLES	YES	YES	YES	
ARCNET & COMPATIBLES		YES	YES	
AT&T STARLAN				
PC NETWORK 2				

NOTES AND COMMENTS

LAN NETWORK OPERATING SYSTEM PRODUCT FEATURES

SERVER PARAMETERS:	NOS VENDORS #1	#2	#3	WEIGHT
MAXIMUM SIMULTANEOUS USERS PER SERVER				
MAXIMUM SERVER VOLUME SIZE				
MAXIMUM NUMBER OF VOLUMES				
MAXIMUM SHARED PRINTERS PER SERVER				
MAXIMUM SIMULTANEOUS DOS SPACE LOCK-KB				
MAXIMUM OPEN FILES ON ONE SERVER				
OPERATING SYSTEM SUPPORT				
FILE SERVER RAM REQUIRED				
MINIMUM WORKSTATION RAM REQUIRED				
MAXIMUM NUMBER OF CONNECTIONS / SERVER				
MAXIMUM SINGLE FILE SIZE				
MAXIMUM LAN DRIVERS				
MAXIMUM DRAM MEMORY ADDRESSABLE				
NETWORK ADAPTERS SUPPORTED				
ETHERNET & COMPATIBLES				
TOKEN RING & COMPATIBLES				
ARCNET & COMPATIBLES				
AT&T STARLAN				
PC NETWORK 2				
WORKSTATION O/S COMPATIBILITIES:				
MS/PC-DOS 2.X - 4.X				
MS-OS/2 1.1				

NOTES AND COMMENTS

LAN NETWORK OPERATING SYSTEM PRODUCT FEATURES

USER ACCOUNT PERMISSIONS:	NOS VENDORS #1	#2	#3	WEIGHT
READ FROM FILE				
WRITE TO FILE				
CREATE NEW FILE				
DELETE FILES				
GRANT PERMISSIONS				
EXECUTE ONLY				
MODIFY FILE ATTRIBUTES				
SET MAXIMUM SIMULTANEOUS USERS				
ASSIGN PERMISSIONS TO DIRECTORIES				
ASSIGN PERMISSIONS TO FILES				
ASSIGN PERMISSIONS TO QUEUES				
ADMIN RIGHTS ASSIGN TO SPECIFIC DIR.				
PERMISSIONS CAN BE INHERITED				
INHERITED RIGHTS CAN BE MASKED				

NOTES AND COMMENTS

LAN NETWORK OPERATING SYSTEM PRODUCT FEATURES

SHARE-LEVEL PERMISSIONS:	NOS VENDORS #1	#2	#3	WEIGHT
READ FROM FILE				
WRITE TO FILE				
CREATE NEW FILE				
DELETE FILES				
EXECUTE ONLY				
SHARE LEVEL PASSWORD FOR PRINTERS				

NOTES AND COMMENTS

LAN NETWORK OPERATING SYSTEM PRODUCT FEATURES

MESSAGES AND CHATTING	NOS VENDORS #1	#2	#3	WEIGHT
SEND MESSAGES				
SEND MESSAGES TO GROUPS				
BROADCAST MESSAGE TO ALL				
IGNORE MESSAGES				
LOG MESSAGES				
HOT KEY TO MESSAGES				
CHATTING				
MAXIMUM NUMBER OF CHATTERS				

NOTES AND COMMENTS

LAN NETWORK OPERATING SYSTEM PRODUCT FEATURES

ARCHIVAL SERVICES:	NOS VENDORS #1	#2	#3	WEIGHT
BACKUP/RESTORE WHOLE SERVER DISK				
BACKUP/RESTORE SELECTED DIRECTORIES				
BACKUP MODIFIED FILES ONLY				
BACKUP SYSTEM FILES				
ON-LINE BACKUP OF ACCOUNT FILES				
AUTOMATICALLY SKIP OPEN FILES				
SCHEDULED BACKUP				
BACKUP TO TAPE				
BACKUP TO MULTIPLE TAPE DRIVES				
BACKUP TO FLOPPY				
BACKUP MACINTOSH FORMAT FILES				
RESTORE FILES WITH ORIGINAL RIGHTS				
MENU DRIVEN BACKUP/RESTORE FRONT-END				
CREATE CATALOG OF FILES ON BACKUP TAPE				
ERROR CORRECTION CAPABILITY				

NOTES AND COMMENTS

LAN NETWORK OPERATING SYSTEM PRODUCT FEATURES

PRINTING QUEUES:	NOS VENDORS #1	#2	#3	WEIGHT
MULTIPLE QUEUES ON ONE PRINTER				
MULTIPLE PRINTERS ON ONE QUEUE				
MULTIPLE QUEUES ON MULTIPLE PRINTERS				
RESTRICT HOURS OF QUEUE OPERATION				
QUEUE PRIORITY LEVELS				
SPECIFY PRINT PREPROCESSOR				
VIEW QUEUE				
CHANGE QUEUE ORDER				
SWITCH QUEUES				
CAN INSERT FILES DIRECTLY INTO QUEUE				
USER CAN DELETE ACTIVE PRINT JOBS				
DELETE JOBS FROM QUEUE				
PLACE JOB ON HOLD/RELEASE FROM HOLD				
RESTART JOB FROM BEGINNING				
PAUSE PRINTER				
PAUSE QUEUE				
CLOSE QUEUE				

NOTES AND COMMENTS

LAN NETWORK OPERATING SYSTEM PRODUCT FEATURES

AUDITING:	NOS VENDORS #1	#2	#3	WEIGHT
LOGINS				
UNSUCCESSFUL LOGIN ATTEMPTS				
LAST SUCCESSFUL LOGIN ATTEMPT				
ATTEMPTED SECURITY VIOLATIONS				
LOGOUTS				
FILE OPEN				
SET AUDITING LEVEL				
AUDIT SPECIFIC RESOURCES				

NOTES AND COMMENTS

LAN NETWORK OPERATING SYSTEM PRODUCT FEATURES

	NOS VENDORS			
ALERT SERVICE:	#1	#2	#3	WEIGHT
DRIVE FULL				
EXCESSIVE ERRORS				
INTRUDER ALERT				
PRINTER PROBLEM				
PRINT REQUEST COMPLETE				

NOTES AND COMMENTS

LAN NETWORK OPERATING SYSTEM PRODUCT FEATURES

CONNECTIVITY:	NOS VENDORS #1	#2	#3	WEIGHT
OS/2 WORKSTATIONS				
OS/2 PROCESS WITH PRIVATE SESSIONS				
SUPPORTS MACINTOSH WORKSTATIONS				
SUPPORTS MACINTOSH AS FILE SERVER				
SUPPORTS VAX AS FILE SERVER				
SUPPORTS VAX AS WORKSTATION				
SUPPORTS NFS WORKSTATIONS				
SUPPORTS NFS FILE SERVERS				
327X COAX GATEWAY				
327X REMOTE GATEWAY				
327X TOKEN RING GATEWAY				
327X BISYNC GATEWAY				
327X TERMINAL EMULATION				
ASYNCHRONOUS GATEWAY				
MAX SERIAL DEVICES IN ASYNC GATEWAY				
QUEUE ACCESS TO SERIAL DEVICES				
AT&T UNIX STREAMS SUPPORT				

NOTES AND COMMENTS

LAN NETWORK OPERATING SYSTEM PRODUCT FEATURES

BRIDGING:	NOS VENDORS #1	#2	#3	WEIGHT
SUPPORTS REMOTE WORKSTATION CONNECTS				
SUPPORTS REMOTE SERVERS				
MAXIMUM NUMBER OF LANS / ONE SERVER				
MAXIMUM NUMBER EXTERNAL BRIDGES				
TCP/IP BRIDGE				
HDLC BRIDGE				
X.25 POINT-TO-POINT BRIDGE				
X.25 MULTIPOINT PACKET-SWITCH BRIDGE				
ASYNCHRONOUS BRIDGE				
SCHEDULED CONNECTIONS				
SET LINE DROP ON SPECIFIED IDLE TIME				

NOTES AND COMMENTS

LAN NETWORK OPERATING SYSTEM PRODUCT FEATURES

FAULT TOLERANCE:	NOS VENDORS #1	#2	#3	WEIGHT
UPS MONITORING				
DISK MIRRORING				
DISK DUPLEXING				
SERVER DUPLEXING				
SPLIT SEEKS				
READ AFTER WRITE				
HOT FIX				
SECTOR FAILURE WITH MIRRORED DRIVE				
SUPPORT MULTIPROCESSOR SERVER				

NOTES AND COMMENTS

LAN NETWORK OPERATING SYSTEM PRODUCT FEATURES

SECURITY	NOS VENDORS #1	#2	#3	WEIGHT
USER-BASED SECURITY				
MS-NET TYPE "SHARE" SECURITY				
CREATE SECURITY GROUPS				
SECURITY EQUIVALENCES				
SET ACCOUNT EXPIRATION DATE				
TIME RESTRICTIONS				
LOCKOUT AFTER MULTIPLE FAILED P/WORDS				
DESIGNATE INTRUDER DETECT THRESHOLD				
SET LOGIN ACCOUNT RETENTION TIME				
MANDATORY PASSWORD CHANGES				
LIMIT CONCURRENT CONNECTIONS				
USER SET PASSWORD - ALLOW/PREVENT				
SET MINIMUM PASSWORD LENGTH				
DISABLE AND LOCK ACCOUNTS				
REQUIRE UNIQUE PASSWORDS				
RESTRICT TO SPECIFIED WORKSTATIONS				
AUTO-DISCONNECT AFTER INACTIVE PERIOD				

NOTES AND COMMENTS

LAN NETWORK OPERATING SYSTEM PRODUCT FEATURES

ACCOUNTING:	NOS VENDORS #1	#2	#3	WEIGHT
LIMIT DISK SPACE FOR ACCOUNTS				
TRACK USER ACCESS TIME				
TRACK USER DATA READS				
TRACK USER DATA WRITES				
TRACK USER SERVER REQUESTS				
TRACK USER SPACE USAGE				
CHARGE USERS FOR SERVICES				
RATES VARY BY DAY AND TIME				
SET USER ACCOUNT BALANCES				
SET USER CREDIT LINE				
LOG OFF USER EXCEEDING CREDIT LINE				

NOTES AND COMMENTS

LAN NETWORK OPERATING SYSTEM PRODUCT FEATURES

ELECTRONIC MAIL:	NOS VENDORS #1	#2	#3	WEIGHT
CREATE MAIL GROUPS				
CERTIFIED MAIL				
FORWARD RECEIVED MAIL				
FORWARD WITH COMMENTS				
CC LISTS				
EDIT AND SAVE RECEIVED MAIL				
DATE AND TIME STAMP				
MAXIMUN NUMBER OF ATTACHED FILES				
EDITOR CAN READ IN TEXT FROM A FILE				
PRINT E-MAIL				
INTER-POST OFFICE MAIL				
MAIL GATEWAYS				
HOT KEY TO MAIL FACILITY				
MAIL IS ENCRYPTED				
STORE MAIL IN MULTIPLE FOLDERS				
SORT MAIL				
UNSEND MAIL				
DISCARD MAIL BEFORE SELECTED DATE				

NOTES AND COMMENTS

LAN NETWORK OPERATING SYSTEM PRODUCT FEATURES

APPLICATION PROGRAM INTERFACES:	NOS VENDORS #1	#2	#3	WEIGHT
NAMED PIPES				
NetBIOS				
APPC				
E-MAIL APIs				
AUDITING API				
ACCOUNTING API				
INDEXED FILE MANAGER				
TRANSACTION LOGGIN AND ROLLBACK				
SMB (IBM)				
AFP (MACINTOSH)				
NFS (UNIX)				

NOTES AND COMMENTS

LAN NETWORK OPERATING SYSTEM PRODUCT FEATURES

BUNDLED APPLICATIONS:	NOS VENDORS #1	#2	#3	WEIGHT
MENU DEVELOPMENT UTILITIES				
TIME MANAGEMENT				
DOS COMMAND SHELL				
DATABASE BACKEND				

NOTES AND COMMENTS

LAN NETWORK OPERATING SYSTEM PRODUCT FEATURES

UTILITIES:	NOS VENDORS #1	#2	#3	WEIGHT
SYSTEM LOGIN SCRIPT				
USER LOGIN SCRIPT				
FILE LOCKING-EXPLICIT				
DISPLAY LOGGED IN USERS				
DISPLAY NETWORK RESOURCES IN USE				
DISPLAY RIGHTS				
EXE. SERVER PROGRAM FROM WORKSTATION				

NOTES AND COMMENTS

LAN NETWORK OPERATING SYSTEM PRODUCT FEATURES

SUPERVISOR UTILITIES:	NOS VENDORS #1	#2	#3	WEIGHT
FORCED DISCONNECT				
SECURITY CHECK UTILITY				
LIST SECURITY GROUP ACCESS LIMITS				
LIST USER ACCESS LIMITS				
LIST USER ACCESS RIGHTS / RESOURCE				
REMOTE ADMIN. OF FILE SERVERS				
REAL-TIME STATUS: FILES/VOLUMES				
ADMIN. MULTIPLE SERVERS FROM WORKST.				
AUTOMATIC UPDATE: WORKSTATION SHELL				

NOTES AND COMMENTS

LAN NETWORK OPERATING SYSTEM PRODUCT FEATURES

PERFORMANCE MONITORING:	NOS VENDORS #1	#2	#3	WEIGHT
AVERAGE RESPONSE TIME				
CACHE STATISTICS				
SERVER CPU UTILIZATION				
NUMBER PACKETS/BYTES SENT/RECEIVED				
PACKETS/BYTES PER SECOND				
NUMBER OF BAD PACKETS				
CURRENT NUMBER OF FILES OPEN				
PEAK FILES OPEN				
CURRENT NUMBER OF RECORD LOCKS				
PEAK NUMBER OF RECORDS LOCKS				
CURRENT NUMBER OF CONNECTIONS				
PEAK NUMBER OF CONNECTIONS				
NUMBER OF DISK BLOCKS READ/WRITTEN				
NUMBER OF DISK BLOCKS PER SECOND				
DISK UTILIZATION				
DISK DEMAND VERSUS SERVICE				
NUMBER OF DRIVE I/O ERRORS				
NUMBER OF PACKETS ROUTED				
PEAK PACKETS ROUTED PER SECOND				
SERVER OPERATOR CAN CLEAR STATISTICS				
IDENTIFY TOKEN RING BEACON SENDER				

NOTES AND COMMENTS

LAN NETWORK OPERATING SYSTEM PRODUCT FEATURES

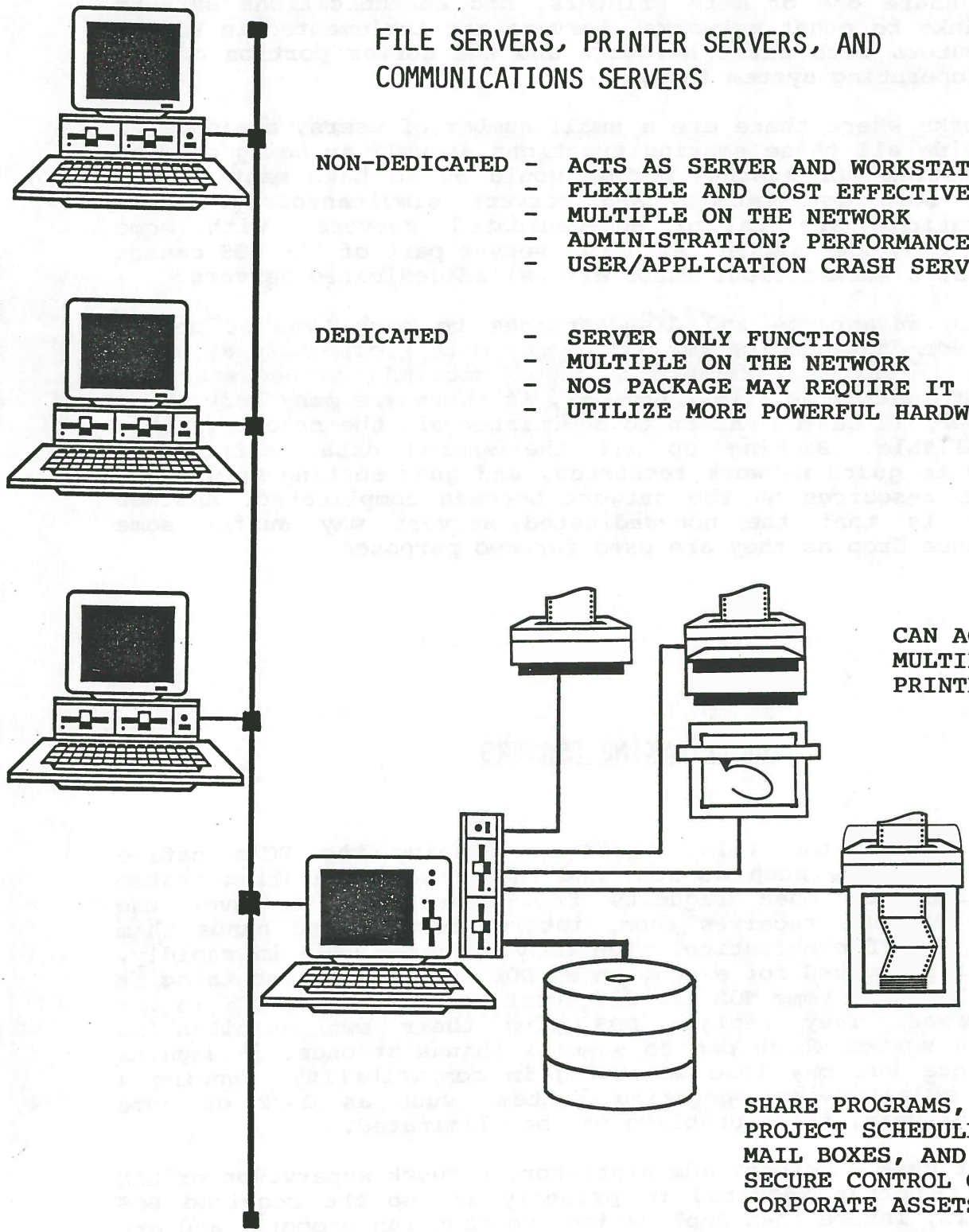
NETWORK PRINTING:	NOS VENDORS #1	#2	#3	WEIGHT
AUTOMATIC CLEAR				
PRINT BANNER				
LIST AVAILABLE PRINTERS/QUEUES				
LIST CURRENT RESTRICTIONS				
SHOW PRINTER STATUS FROM REMOTE W/S				
END SPOOL FROM WITHIN APPLICATION				
SET TIME OUT FOR REMOTE SPOOL				
SEND PRINT OUTPUT TO NETWORK FILE				
SELECT PRINT MODE FOR TARGET PRINTER				
SELECT FORM TYPE FOR TARGET PRINTER				
AUTOMATIC POSTSCRIPT FONT DOWNLOAD				
AUTO HP LASERJET FONT DOWNLOAD				
PRINT SCREEN TO NETWORK PRINTER				
NOTIFICATION OF PRINT COMPLETION				
MULTIPLE USER DEFINED PRINTER CONFIG				

NOTES AND COMMENTS

SECTION 9.0

LAN SERVERS

TYPES OF LAN SERVERS



FILE SERVERS, PRINTER SERVERS, AND COMMUNICATIONS SERVERS

NON-DEDICATED
- ACTS AS SERVER AND WORKSTATION PC
- FLEXIBLE AND COST EFFECTIVE
- MULTIPLE ON THE NETWORK
- ADMINISTRATION? PERFORMANCE?
- USER/APPLICATION CRASH SERVER

DEDICATED
- SERVER ONLY FUNCTIONS
- MULTIPLE ON THE NETWORK
- NOS PACKAGE MAY REQUIRE IT
- UTILIZE MORE POWERFUL HARDWARE

CAN ACCESS MULTIPLE TYPES OF PRINTERS

SHARE PROGRAMS, FILES, PROJECT SCHEDULES, MAIL BOXES, AND KEEP SECURE CONTROL OVER THE CORPORATE ASSETS.

THE SERVER FUNCTION

The term server is a general one that means "in charge of sharing". File servers share data files and programs, print servers share one or more printers, and communications servers share links to other networks. Servers are implemented in PCs or minicomputers with extra hardware and the server portion of the network operating system (NOS).

In networks where there are a small number of users, a single PC may provide all these sharing functions as well as being used as a workstation PC. Another option would be to have many PCs be used as both workstations and servers simultaneously. These configurations are called non-dedicated servers. With some vendor's NOS, the machine with the server part of the NOS cannot be used as a workstation. These are called dedicated servers.

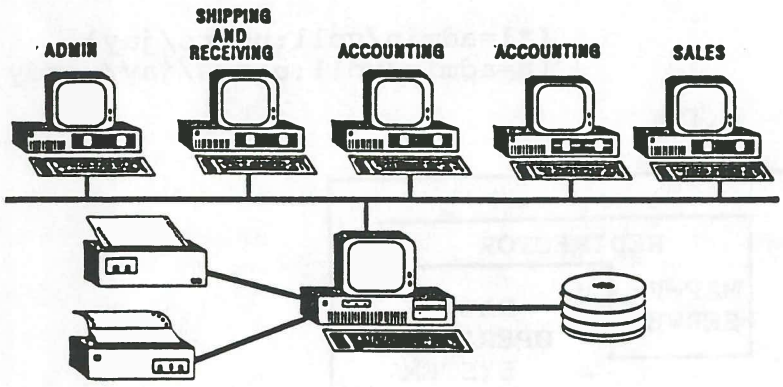
There are advantages and disadvantages to each type of server set-up. Non-dedicated servers allow for more flexibility as users can make resources available on their machines as necessary to share information or files. However, if there are many servers on the network it can be harder to administer all the resources that are available. Backing up all the shared data, setting up security to guard network resources, and just setting up who can use what resources on the network becomes complicated. Another drawback is that the non-dedicated servers may suffer some performance drop as they are used for two purposes.

MULTITASKING SERVERS

In most cases the file server is running the PC's native operating system, such as DOS, and the network operating system (NOS) together. When requests from users come in over the network, the NOS receives them, interprets them and hands them to, say, DOS for execution. When many requests come in rapidly, they must be queued for execution as DOS can only do one thing at a time. However, some NOS are different and do not run DOS in the file server. They replace DOS with their own multitasking operating system which can do several things at once. This gains performance but may lose something in compatibility. Running a general multitasking operating system, such as OS/2 or some version of Unix, these problems may be eliminated.

In either case a network administrator, network supervisor or LAN Manager is often required to properly set up the required NOS parameters, insure that application programs run properly and are compatible with the network, and generally assist the network users.

FILE ACCESS SECURITY



PASSWORDS - SYSTEM

RIGHTS - DIRECTORIES

FLAGS - FILES

COMPANY RECORDS ON THE SERVER MAY HAVE TO BE SHARED IN SOME FORM OR ANOTHER AMONG MANY PEOPLE AND AREAS SUCH AS:

- DATABASE OF CUSTOMER RECORDS
- DATABASE WITH SALES ORDERS
- CONTRACTS AND PROPOSALS
- CORRESPONDENCE
- SALES OBJECTIVES
- INDIVIDUAL SALES RECORDS
- PERSONNEL RECORDS
- PURCHASING RECORDS
- INVENTORY RECORDS
- ACCOUNTS RECEIVABLES
- INSURANCE RECORDS
- TAX RECORDS

RIGHTS TO DIRECTORIES MAY INCLUDE:

READ WRITE OPEN CREATE DELETE
SEARCH MODIFY PARENTAL (GRANT RIGHTS)

IN NETWARE, THESE SECURITY RIGHTS ARE CALLED DIRECTORY RIGHTS WHEN APPLIED TO THE DIRECTORIES AND THEIR CONTENTS AND TRUSTEE RIGHTS WHEN APPLIED TO USERS AND GROUPS. YOUR SUPERVISOR ASSIGNS A COMBINATION OF THESE RIGHTS TO EACH DIRECTORY AND USER OR GROUP.

FILE FLAGS

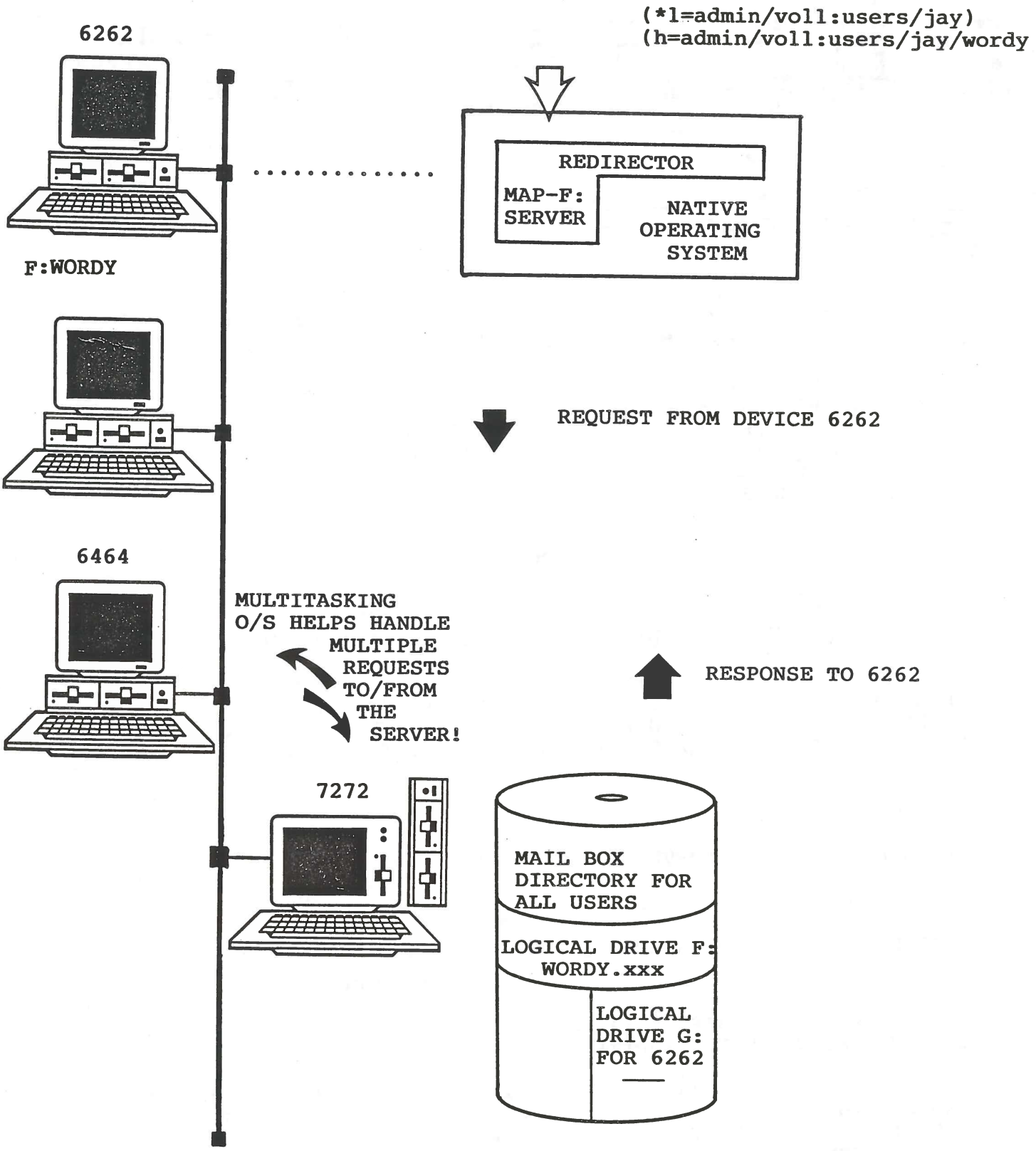
FLAGS ARE A WAY OF PREVENTING ACCIDENTAL CHANGES TO A FILE. THEY ARE ADDED WHEN THE FILE IS CREATED BY MARKING A FILE WITH THE APPROPRIATE LIMITATION:

SHARABLE NONSHARABLE READ/WRITE READ/ONLY
INDEXED TRANSACTIONAL

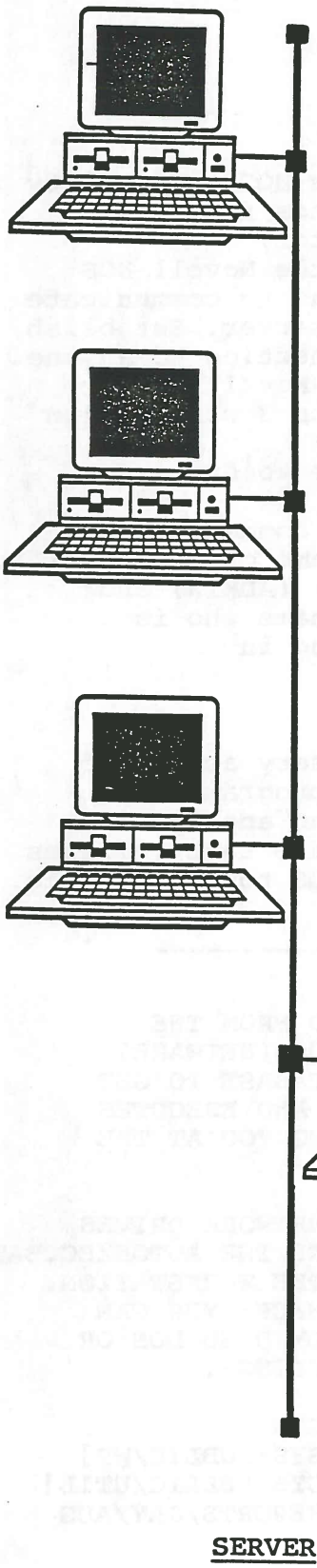
A MEMO MARKED "SHARABLE READ/ONLY" CAN BE ACCESSED BY EVERYONE IN THE OFFICE BUT NOT MODIFIED.

THE SERVER NOS, NETWARE, LOOKS AT THE FILES YOU WISH TO ACCESS AND HOW THOSE FILES ARE MARKED AND INFORCES THE LIMITATIONS. ALL FILES IN A DIRECTORY CAN BE VIEWED AS TO THEIR FLAG DESIGNATION.

NETWORK OPERATING SYSTEM MAPPING



LINKING THE WORKSTATION PC TO THE SERVER



CONFIG.SYS FILE

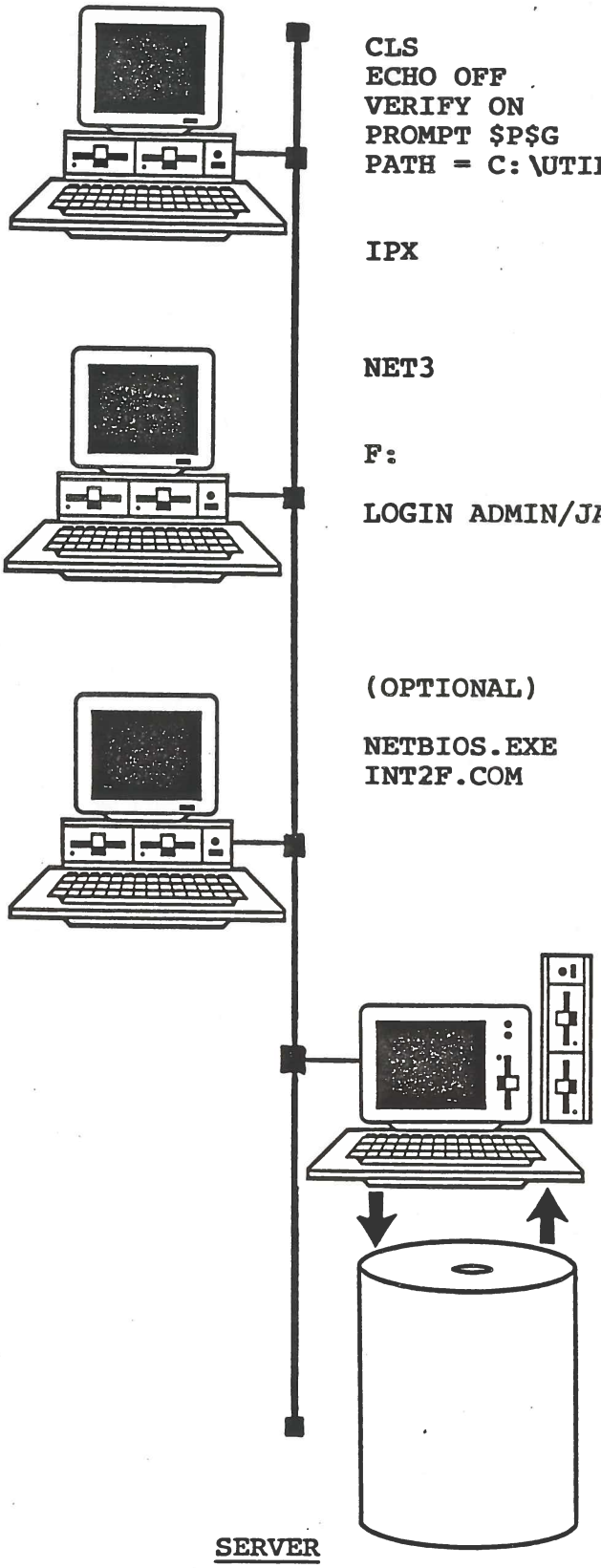
```
BUFFERS = 18                          - Set number of files/
FILES = 100                             disk buffers and
SHELL = C:COMMAND.COM  /P             - Where other command
                                        processor located
DEVICE = C:\UTIL\VDISK.SYS
                                      - Where other
DEVICE = C:\UTIL\MSMOUSE.SYS            drivers are
DEVICE = C:\UTIL\ANSI.SYS               located

LASTDRIVE = E:                        - Name of last
                                        local drive
                                        designator, network
                                        drive designators
                                        start from here.
```

NETWORK DRIVE DESIGNATORS MAYBE ASSIGNED DYNAMICALLY AFTER THE LAST LOCAL DRIVE OR HARD ASSIGNED TO SPECIFIC FUNCTIONS/DIRECTORIES IN THE SERVER.

SERVER

LINKING TO THE SERVER

AUTOEXEC.BAT FILE



```
CLS
ECHO OFF
VERIFY ON
PROMPT $P$G
PATH = C:\UTIL; C: DOS      - Access DOS and utility
                              commands from any
                              directory
IPX                         - Load the Novell NOS
                              program to communicate
                              with server. Establish
                              a connection to anyone.
NET3                        - Loads Novell Netware
                              version 3 workstation
                              shell
F:                          - Change to drive F:
LOGIN ADMIN/JAY             - Login command with
                              the name of the specific
                              server (ADMIN) and
                              user name who is
                              logging in

(OPTIONAL)

NETBIOS.EXE                 - Necessary action to
INT2F.COM                     load programs if
                              running application
                              software that requires
                              NETBIOS to communicate.
```

WHEN PASSWORD ACCEPTED FROM THE NETWORK, THE SERVER NOS (NETWARE) CHECKS THE BINDERY DATABASE TO GET INFORMATION ABOUT YOU AND EXECUTES A SCRIPT BEFORE LEAVING YOU AT THE PROMPT.

LOGIN SCRIPT SETS UP NETWORK DRIVES ON THE SERVER MUCH LIKE THE AUTOEXEC.BAT AUTOEXEC.BAT FILE IN THE WORKSTATION. A PERSONAL SCRIPT IS WHERE YOU CAN KEEP YOUR MOST COMMONLY USED DOS OR OTHER COMMANDS AND MAPPINGS.

```
DRIVE F: ADMIN/JAY:LOGIN
SEARCH3: = X: [ADMIN/SYS:PUBLIC/WP]
SEARCH4: = W: [ADMIN/SYS:PUBLIC/UTIL]
DRIVE H: = ADMIN/SYS:REPORTS/JAY/AUG
```

SERVER

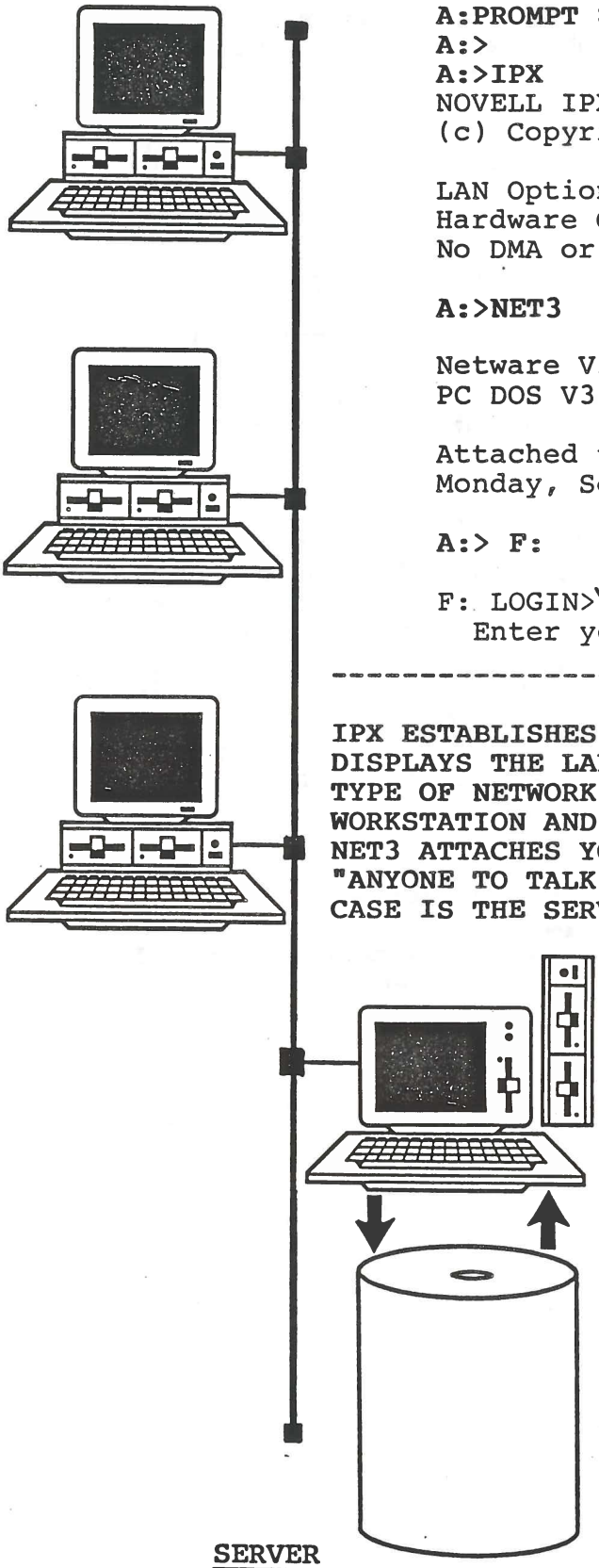
ESTABLISHING THE LINK TO THE SERVER

How does the file server know who you are and what drive F: (from the previous example) means when a command comes across the network? To do this requires an initilization step which is often called logging on to the network. Workstation PCs don't always have to be logged on to the network; however, it is wise to do this when the workstation PC is turned on to take full and automatic advantage of the network resources. For example, you may want to print a document and need the network printer. Also, more and more LAN workstation PCs come diskless, which means all activity is initiated from the server. An automatic log on procedure is usually used to facilitate network access, which occurs when you power up the workstation PC.

When you turn on your workstation PC, it first performs a self-check, called Power On Self Test to make sure all the hardware is in place and ready. Next it loads two specific files from your Boot disk or hard drive called CONFIG.SYS file and AUTOEXEC.BAT file if you have a DOS computer. The CONFIG.SYS file helps DOS set up parameters that define your workstation PC's environment such as how many buffers to use, how many files can be open at once, where device drivers are located and the name of the last local drive. This would be C: if you had two floppy drives and one hard drive. The AUTOEXEC.BAT file contains a list of commands that will be executed automatically before any keyboard commands can be entered. Before you can use the network, your workstation PC must load in certain software programs that enable your network interface card to communicate with the server and the redirector. These make up the workstation PC's part of the network operating system (NOS) and are often initiated from the AUTOEXEC.BAT file. Other utility programs may be loaded in this manner also. These programs would generally be stored on the workstation PC's hard disk.

One of these NOS programs will automatically establish communications with one server after it has been loaded. You will next see on the screen a prompt, like the drive prompt F:, followed by a request to enter the desired server you wish to connect to and your user name. If the requested server has a record of you it will send back a request to enter your password, which if entered correctly, you will be logged onto that server. This logical connection, using the data delivery protocols discussed earlier, is called a session. At this point, the server will execute a login-profile or login script routine defined for you. This is like the AUTOEXEC.BAT file procedure but loaded on the server. It automatically executes commands that you need to support your server connection and it maps drives to directories on the server. For example, you are now left at the drive F: prompt on your workstation PC which might be mapped to a server directory used for receiving your electronic mail.

SCREEN DISPLAY (NOVELL'S NETWARE EXAMPLE)



```
A:PROMPT $P $G
A:>
A:>IPX
NOVELL IPX/SPX V2.12
(c) Copyright 1985, 1988 Novell Inc

LAN Option: Netware Ethernet NE-1000 V2.30 EC
Hardware Configuration IRQ=3, I/O Base=300h
No DMA or ROM

A:>NET3

Netware V2.12 rev. A Workstation Shell for
PC DOS V3.x (C) Copyright 1983, 1988 Novell

Attached to server PUB
Monday, September 15, 1989 12:22:17 pm

A:> F:

F: LOGIN>\LOGIN ADMIN\JAY
  Enter your password:
```

IPX ESTABLISHES COMMUNICATIONS WITH THE NETWORK AND DISPLAYS THE LAN DRIVER INFORMATION TELLING YOU WHAT TYPE OF NETWORK INTERFACE BOARD IS INSTALLED IN THE WORKSTATION AND ABOUT THE BOARD'S INTERRUPT SETTINGS. NET3 ATTACHES YOU TO THE FIRST SERVER THAT ANSWERS THE "ANYONE TO TALK TO OUT THERE" BROADCAST, WHICH IN THIS CASE IS THE SERVER PUB.

AT THIS POINT MAY ALSO ATTACH TO SEVERAL OTHER SERVERS ON THE NETWORK SIMULTANEOUSLY.

SERVER

HOW DOES THE SERVER KNOW WHO CALLED?

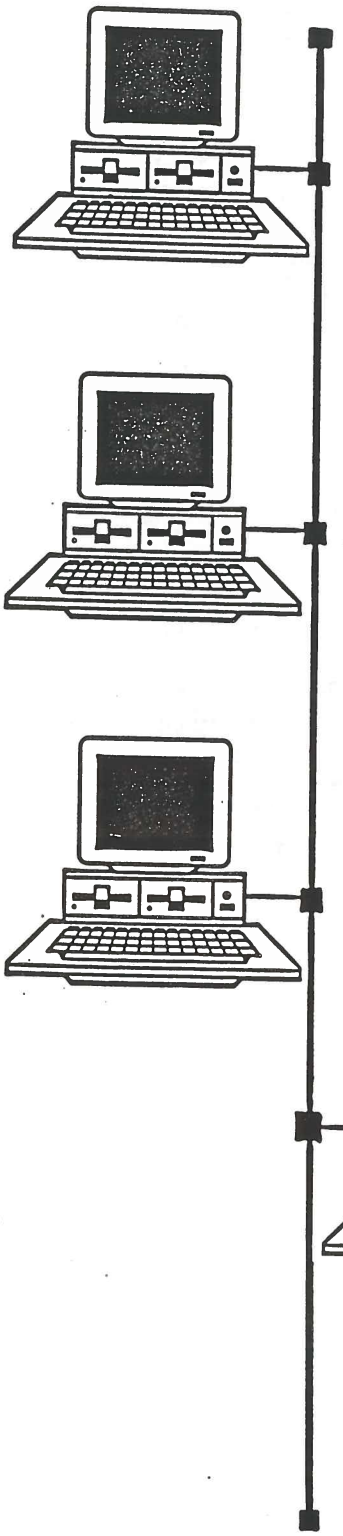
The transmission protocols like CSMA/CD or Token Passing send packets of data around the network. Each packet has fields which contain the device address the packet was sent from and the device address to which the packet is being sent. The NOS in the workstation PC knows the address of the server or is provided the server's address during the course of the log-on procedure and passes it to the transmission protocol software that creates the packet. Some log-on procedures initially issue an "ANYONE THERE?" packet looking for a start-up server. The transmission protocol software comes with the network interface card (NIC) installed in the workstation PC. The workstation PC has its own unique address which maybe assigned by the network administrator or it may be the address embeeded in all the NICs by the manufacturer. This is the address included in every packet. During the log-on procedure, the server reads the sending NIC's address and relates it to the session just established between the workstation PC and the server.

SERVER ACCESS SECURITY

Access security is an important function of the NOS and often includes several levels of access protection. Before a workstation PC can gain access to a server a password must be entered and accepted by the server. Once logged into the server, various directories can be accessed based upon a user's profile; however, what you can do with these directories depends on another security structure. For example, you may be able to READ, SEARCH, OPEN, CREATE, MODIFY, or DELETE files in a particular directory or perform some combination of these tasks. In addition there maybe files in the directory which have been marked READ ONLY, READ WRITE or SHARABLE that may provide further restrictions over having FULL ACCESS RIGHTS for the directory.

In addition to privaledges on the connected server you may also have some access rights to information on other servers. In this case you maybe logged into one server but be able to attach to other servers at the same time.

NETWORK PRINTING

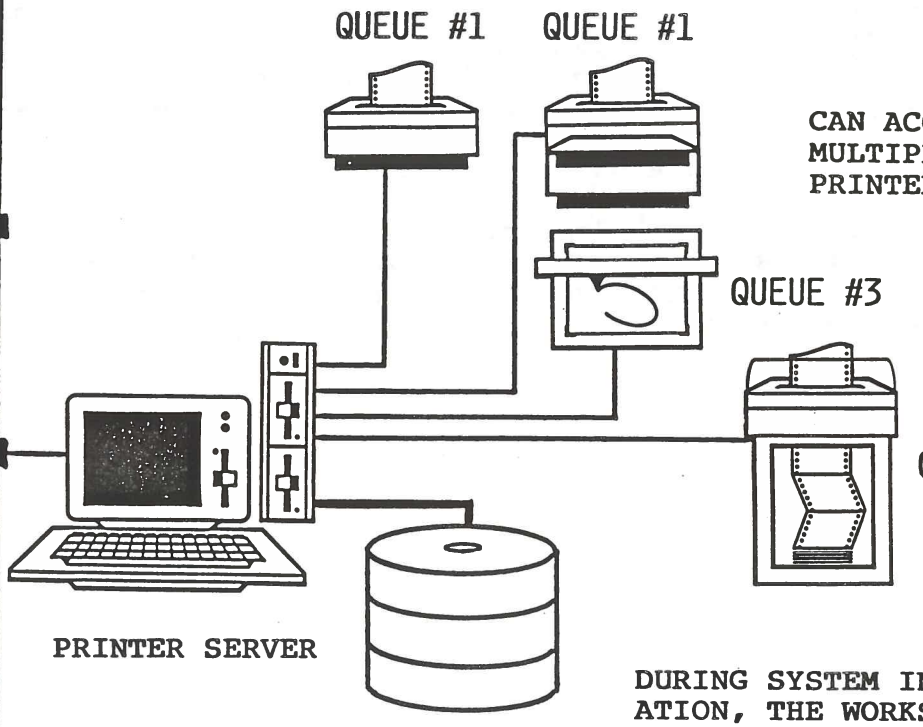


"DUMB" APPLICATION — NOT ABLE TO SPECIFY A NETWORK PRINTER FOR THE OUTPUT SO THE NETWORK OPERATING SYSTEM HELPS OUT.

"SMART" APPLICATION

"NETWORK" APPLICATION — ABLE TO ROUTE THEIR OWN PRINT TO THE NETWORK SERVER BY NAME OR EVEN THE QUEUE FOR EACH FILE.

THE PRINTER SERVER FUNCTIONS ARE USUALLY PART OF THE NOS THAT IS ALSO RUN ON THE SAME MACHINE AS THE FILE SERVER. IT HANDLES THE JOB OF MANAGING THE PRINT RESOURCES. SPECIAL COMMANDS CAN BE INVOKED FOR SPECIFIC TREATMENT OF FILES. SOME NOS PACKAGES PROVIDE UNIVERSAL PRINTER SERVICES USING ANY PRINTER IN THE NETWORK NOT JUST ONES PHYSICALLY ATTACHED.



CAN ACCESS MULTIPLE TYPES OF PRINTERS

DURING SYSTEM INITIALIZATION, THE WORKSTATION NOS WAS SET UP TO SEND ALL PRINT TO A SPECIFIC NETWORK PRINTER BUT THIS CAN BE MODIFIED BY THE WORKSTATION OPERATOR WITH NOS COMMANDS.

SHARING PRINTERS ON THE NETWORK

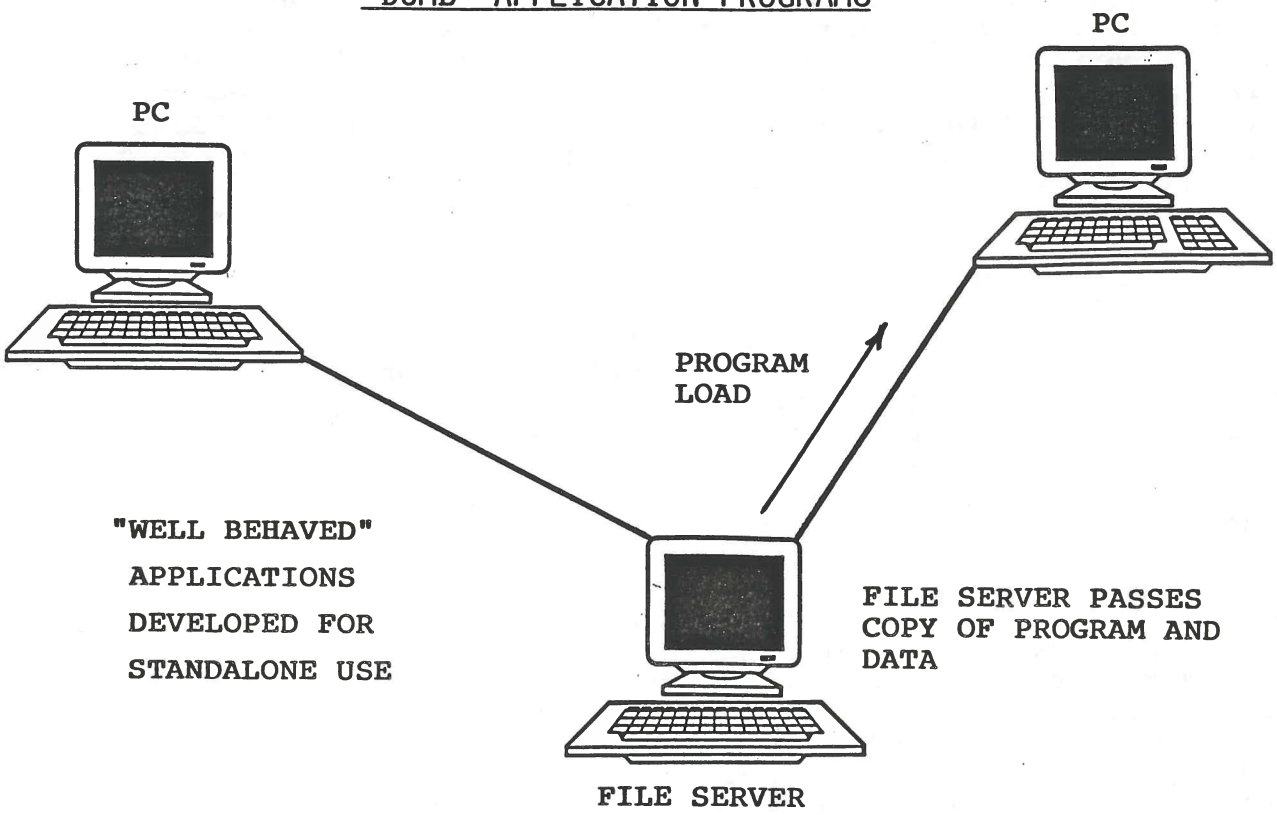
Printing files or reports on a network printer is usually more involved than simply using the local PC attached printer, although even that can be frustrating at times. Application programs, like your word processor, fall into three categories relative to printing capabilities. The first, called "DUMB" APPLICATION, always send printout to a particular printing port on the PC, usually LPT1. "SMART" APPLICATION programs allow you to designate which PC port to print to such as LPT1, LPT2, LPT3, COM1, or COM2. In either case, to send the output from these applications to the network printer, the NOS utility in the workstation PC must redirect files designated for some or all of these output ports and route them to the proper printer server on the network. A third kind of application program, called "NETWORK" APPLICATION programs, can route their own print to the network server without the help of the NOS utility. These applications allow you to designate the printer server name or even the printer queue name to which the file is to be sent on the network.

A printer server is a machine with special NOS functions to handle the job of managing the printer resources in the network. This software may run in an existing file server machine, it may run as a non-dedicated server in a workstation PC or it may run as a dedicated server in a separate machine. The server may have several printers attached to it and use one or more print queues. A print queue is basically a list of the print jobs or print files waiting to be printed. Queuing is necessary because many network users may send files to the print server at about the same time; therefore, some files must wait until a printer becomes free. Some NOS packages support a universal printer server for the network which can send print files to any available printer on the network not just the printer physically attached to the server.

In most cases a workstation PC's print will always be routed to a specific printer or queue; however, at times you may want to change this. There maybe a specific type of printer, for example a color printer, plotter or laser, that your output requires. There also maybe a need to hold the print file in queue until later at night so as not to tie up the office printers with a long file. These exceptions are handled by additional NOS commands that you may enter, generally at the keyboard, to inform the print server of your requirents.

NETWORK IGNORANT APPLICATIONS

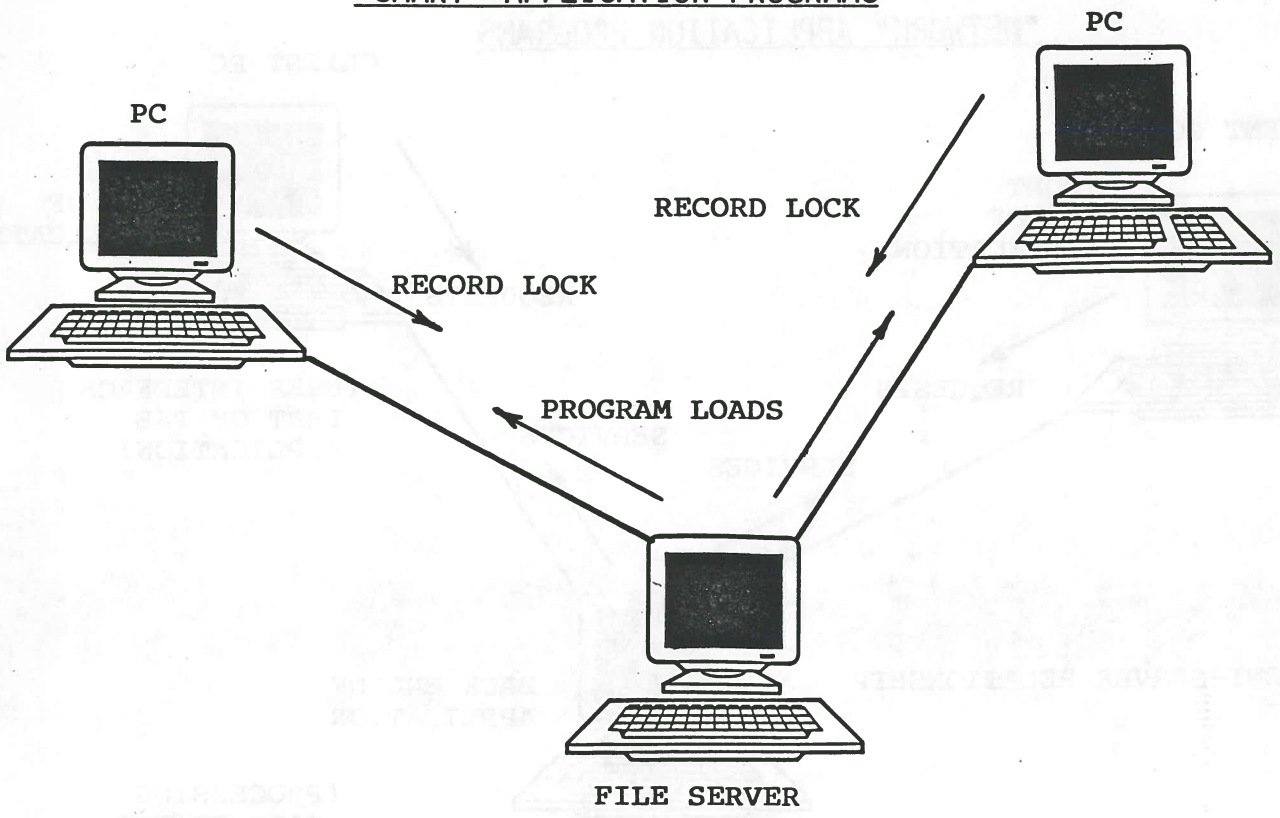
"DUMB" APPLICATION PROGRAMS



NETWORK IGNORANT APPLICATIONS WERE CREATED FOR STANDALONE PCs AND MAY RUN ON A NETWORK IF THEY ARE "WELL BEHAVED"; THAT IS, WHEN THEY GO TO LOOK FOR DATA, THEY DON'T CARE WHERE IT IS STORED, OR WHEN THEN PRINT, THEY DON'T CARE WHERE THE DATA GOES. USUALLY, NETWORK IGNORANT PROGRAMS CAN ONLY BE USED BY ONE PERSON AT A TIME OTHERWISE USERS CAN WRITE OVER EACH OTHERS DATA. IT MUST HAVE CONCURRENCY CONTROL CAPABILITIES. ALSO, IF THE PROGRAM CAN NOT WORK ON A NETWORK IT MAY CAUSE THE PC TO HANG UP, FORCING A REBOOT AND LOSS OF DATA.

NETWORK AWARE APPLICATIONS

"SMART" APPLICATION PROGRAMS

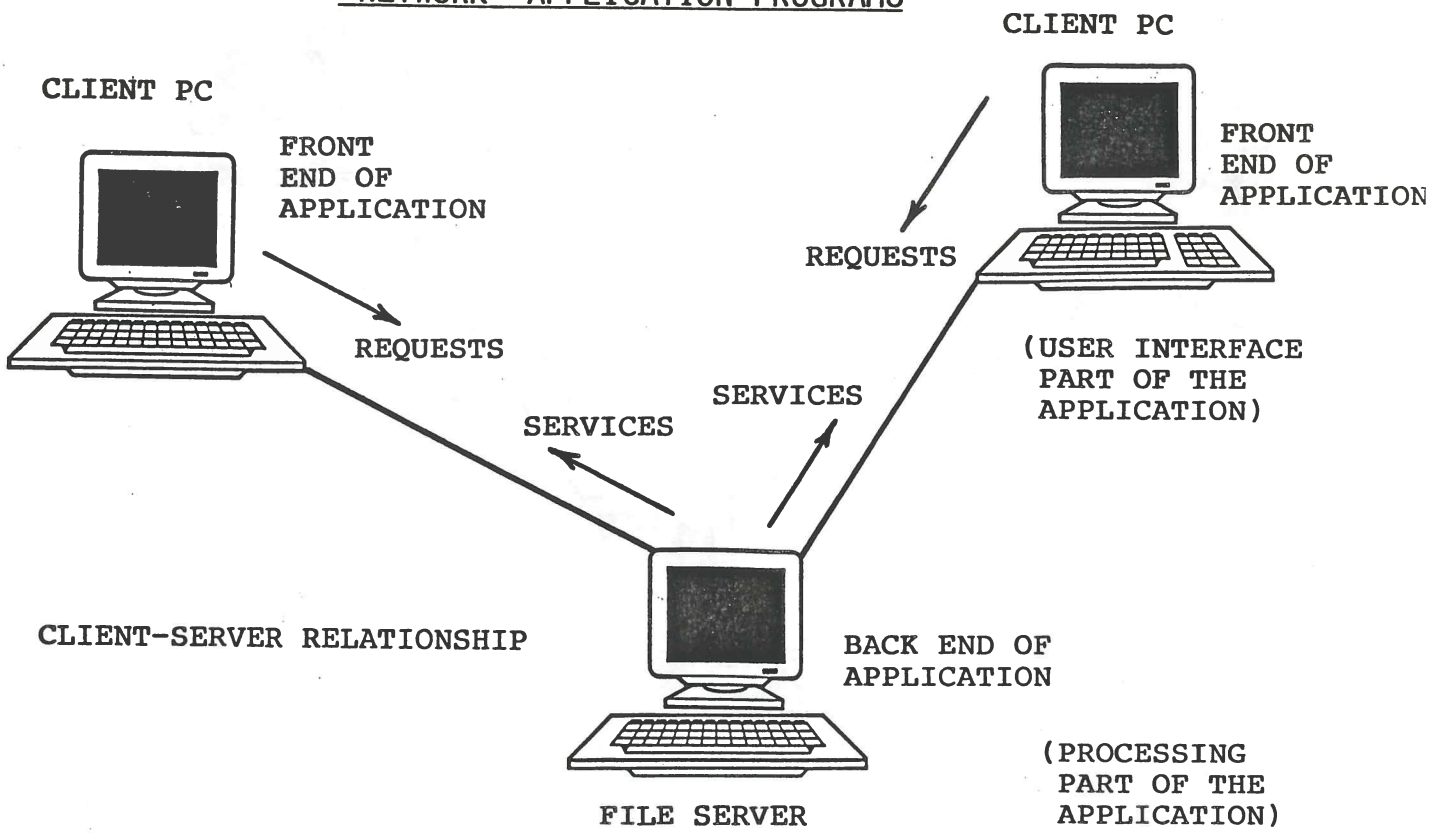


NETWORK AWARE APPLICATIONS RECOGNIZE A NETWORK AND ACT ACCORDINGLY. CONCURRENCY CONTROL FEATURES LIKE FILE LOCKING, RECORD LOCKING, AND COMMUNICATIONS HELP IT COORDINATE ACTIVITIES WHILE MAINTAINING DATA INTEGRITY. MULTIUSER DATABASE PROGRAMS, PRINT SPOOL PROGRAMS, ACCOUNTING PROGRAMS, AND WORD PROCESSOR PROGRAMS ARE EXAMPLES.

NETWORK AWARE PROGRAMS ACTUALLY RUN IN MEMORY OF THE WORKSTATION, EVEN IF THEY ARE STORED ON THE NETWORK FILE SERVER AND COMMUNICATE WITH THE PHYSICAL DATA STORED ON THE SERVER TO MAINTAIN CONCURRENCY CONTROL. IN THIS WAY, ONE INSTANCE OF THE PROGRAM IN ONE WORKSTATION CAN TELL ANOTHER INSTANCE OF THE PROGRAM IN ANOTHER WORKSTATION WHAT IT IS DOING. THIS ALLOWS FOR DATA AND PERIPHERAL SHARING BUT NOT PROCESSOR SHARING.

NETWORK INTRINSIC APPLICATIONS

"NETWORK" APPLICATION PROGRAMS



NETWORK INTRINSIC APPLICATIONS USE PROCESSOR SHARING AND COME IN TWO PARTS WHICH CAN BE SPREAD AROUND THE NETWORK. EACH PART PERFORMS A DIFFERENT TASK FOR THE APPLICATION AND COMMUNICATIONS OVER THE NETWORK KEEPS THE PARTS SYNCHRONIZED. SINCE EACH PROCESSOR IS DEDICATED TO ONLY ONE PART OF THE APPLICATION PERFORMANCE IS IMPROVED.

THE PARTS ARE OFTEN SET UP IN A "CLIENT-SERVER" RELATIONSHIP. ONE PART, THE CLIENT, ASKS THE OTHER PART, THE SERVER, FOR CERTAIN THINGS - OFTEN THERE ARE MANY CLIENTS AND ONE SERVER. PROCESSING TAKES PLACE AT BOTH ENDS. NETWORK INTRINSIC PROGRAMS ARE OFTEN CALLED SERVER BASED PROGRAMS OR DISTRIBUTED APPLICATIONS.

EXAMPLE:

1. USER EXECUTES THE DATABASE LOAD COMMAND ON CLIENT PC
2. A PIECE (NOT ALL) OF THE DATABASE PROGRAM IS LOADED FROM THE SERVER (THIS PART IS CALLED THE FRONT END).
3. USER REQUESTS A SPECIFIC ITEM FROM THE FILE, THE REQUEST IS REDIRECTED OVER THE NETWORK TO THE SERVER.
4. THE BACK END SOFTWARE IN THE SERVER, THE OTHER PART OF THE DATABASE PROGRAM, SEARCHES THE DATABASE FOR THE CORRECT RECORD AND SENDS IT, ONLY ONE RECORD, BACK TO THE CLIENT AND ISSUES A RECORD LOCK ON THAT RECORD SO OTHERS WON'T USE IT, WRITE OVER IT.

dBase IV MICROSOFT WORD NETWORK VERSION LOTUS 1-2-3 NETWORKER
SUPERCALC4 DATAEASE LAN SMART SOFTWARE SYSTEM

APLLICATION PROGRAMS THAT USE THE NETWORK

The term application software or application can be fuzzy when describing LAN operations as there are many programs to contend with on the network. Basically there are four general categories of software found in the network:

1. PC Operating Systems - these run the PC and are quite familiar to any PC user.

2. Network Operating Systems - the programs in this category have been described in the preceeding text.

3. Utility Programs - these maybe found in the workstation PC or a network server and include such items as calendars, pop-up windows or menu generators, terminal emulation programs, electronic mail routines, hard disk back routines, etc.

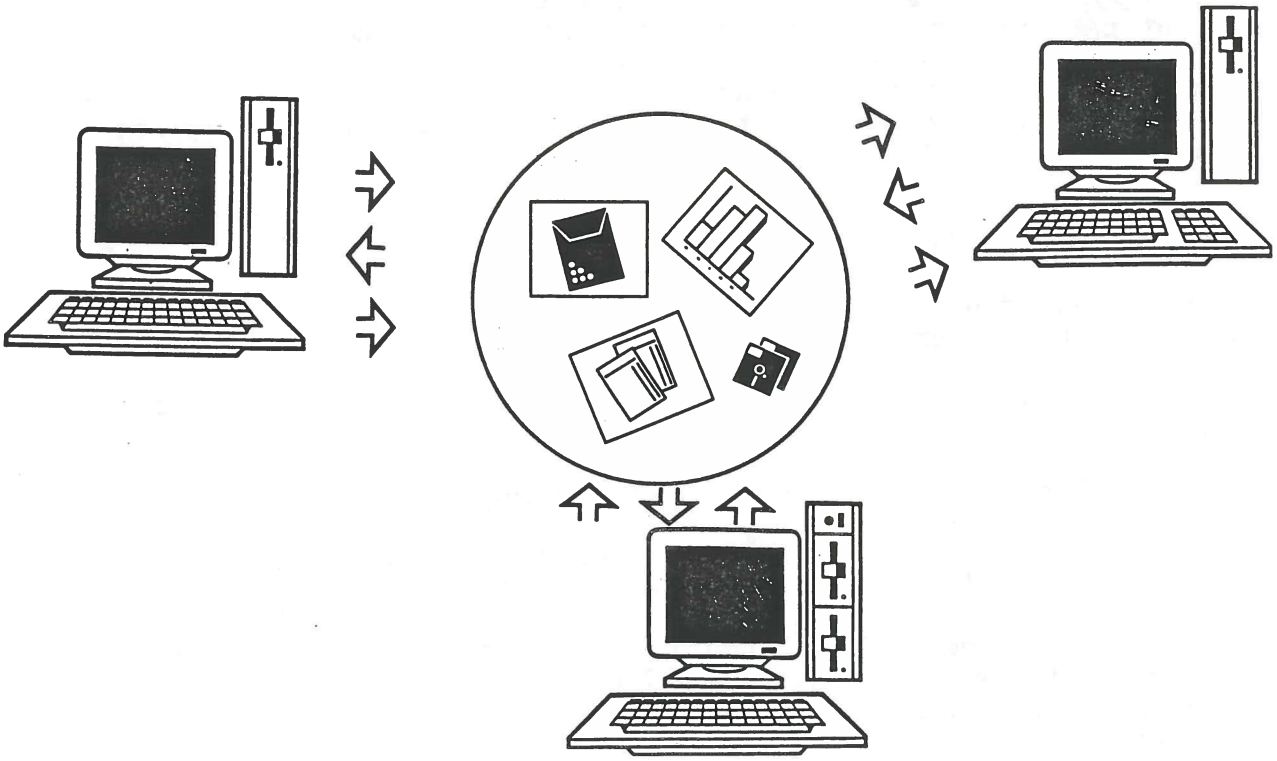
4. Application Programs - generally computer software used to get a job done such as a word processing system program, database programs, spreadsheet programs, or more specific programs like loan application processing.

There are three types of application programs which we used in previous text to describe how they handled the task of printing on a LAN: DUMB applications, SMART applications, and NETWORK applications. However, printing is only one LAN application related concern. LAN dumb applications are programs written for one computer by one user; however, these programs will often run on a network. They can be stored on a file server and used by the workstation PC but often with many limitations. One problem with this type of program is the possibility for two users using the same application and working on the same data file simultaneously on the network. We need concurrency control, which is not provided by this type of application because it thinks there is only one user. We must therefore depend on the NOS for aid with this potential problem. Because these applications are dumb, they also can't take advantage of network functions, services and capabilities.

Smart applications are a step above LAN dumb applications and are often LAN dumb programs modified to run on a network. These recognize they will be used by several users at a time. They have some form of concurrency control like file or record locking. For example, when a database user begins to modify an address in a mailing list, other users looking at the same mailing list at the same time are prevented from changing that address record. When the change is complete the change is displayed on the screen of every other user looking at the file. File locking is a less sophisticated form of concurrency control which prevents other users from accessing the entire file. This is often used by word processing programs. LAN smart programs are now very common and very sophisticated.

CLIENT-SERVER BASED APPLICATIONS

"GROUPWARE"



AT&T'S RHAPSODY LOTUS'S NOTES BRODERBUND'S ForComment

BEYOND SHARING DATA, THESE NEW APPLICATIONS ARE MADE TO RUN ON A LAN USING CLIENT-SERVER TECHNIQUES TO PROVIDE AND SUPPORT TRUE INTERACTION AMONG USERS. TWO KINDS OF PRODUCTS WHICH EITHER ALLOW USERS TO WORK TOGETHER ON A SINGLE PROJECT AND THOSE THAT ORGANIZE THE WAY PEOPLE WORK. GROUPWARE HELPS TO AUTOMATE ROUTINE, DEFINABLE FUNCTIONS, ELIMINATING THE NEED FOR USERS TO PHYSICALLY PASS A DOCUMENT AROUND WHILE EDITING IT, OR TO INFORM A COLLEAGUE IN PERSON THAT A TASK IS DONE.

WORD PROCESSING - A GROUP EDITING PACKAGE FOR USERS WHO HAVE A GREAT DEAL OF CHANGES TO SUPPORT IS IDEAL. USERS MAKING REVISIONS CAN EITHER MAKE COMMENTS OR REWRITE TEXT, AND THE SOFTWARE WILL TAG THEIR REVISIONS. THE AUTHOR CAN THEN BROWSE THROUGH THE REVISIONS AND EITHER INCORPORATE OR DISCARD THEM. USERS CAN ALSO WORK ON DIFFERENT PARTS, PARAGRAPHS, OF THE SAME DOCUMENT SIMULTANEOUSLY. ENGINEERS CAN COLLABORATE ON A CHIP DESIGN OR ARCHITECTS ON A BUILDING PLAN BY LITTERING A SCANNED IN IMAGE WITH THEIR COMMENTS.

AT&T's RHAPSODY BUSINESS ORCHESTRATION SOLUTION HAS SIX INTEGRATED MODULES THAT CONTROL WORKGROUPS AS WELL AS PROVIDE MESSAGING AND PRODUCTIVITY TOOLS. THE WORKFLOW AUTOMATION MODULE IS USER DEFINABLE AND COLLECTS INFORMATION FROM VARIOUS DATA FILES, ASSIGNS TASKS, SCHEDULES MEETINGS, REMINDS PARTICIPANTS, DISTRIBUTES REPORTS, AND TRACKS PROJECT STATUS. IT WILL REACT TO OUTCOME OF PROJECTS AND TAKE APPROPRIATE ACTION, DEFINED BY THE USER.

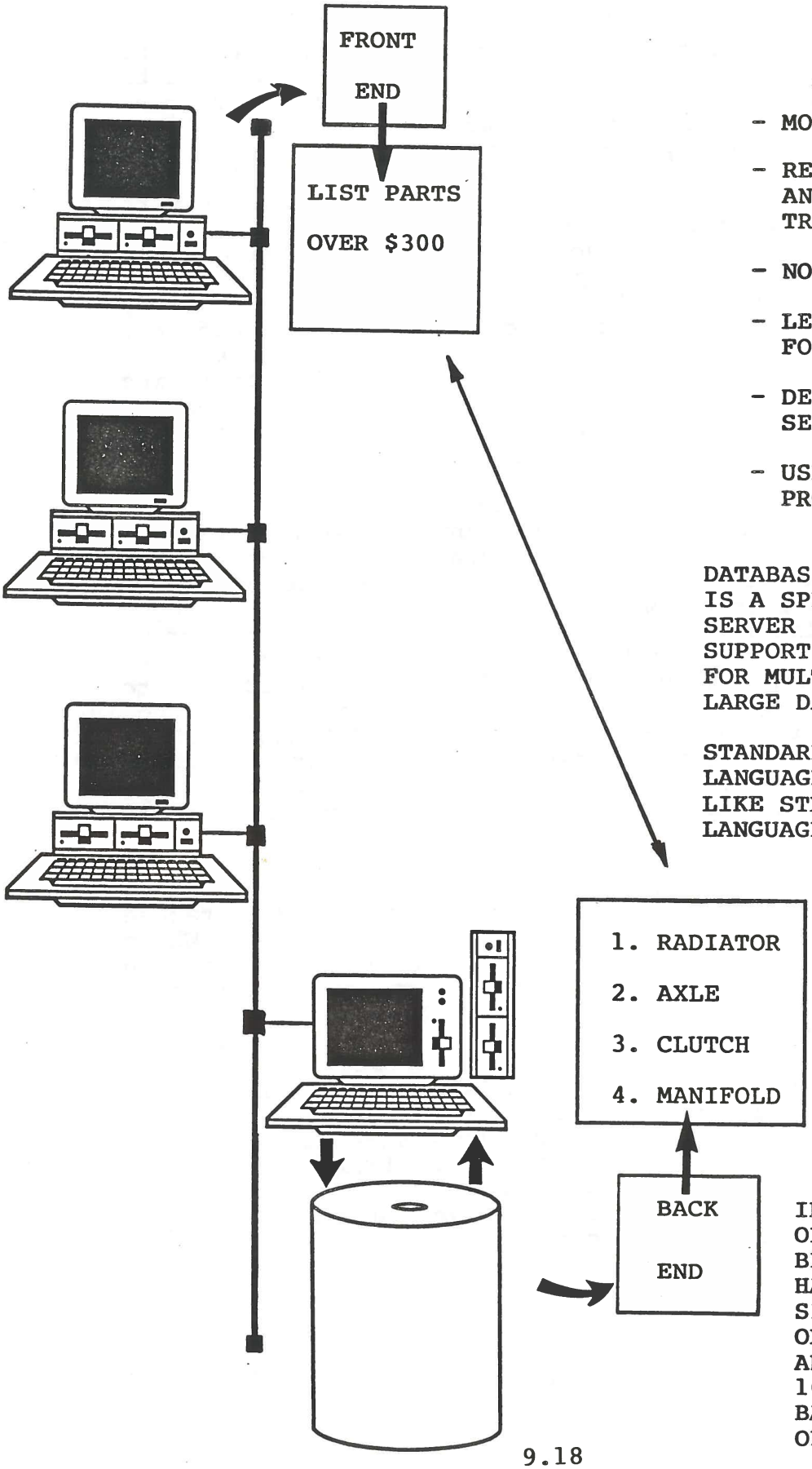
ADVANTAGES OF THE CLIENT-SERVER APPROACH

There are several advantages to the client server approach. First, the network traffic is reduced. Whole files do not have to be transmitted across the network, only a few records. Concurrency traffic is also eliminated as the back-end software takes care of that. Second, programs can be developed to perform specific functions and, therefore, produce an overall more efficient system. Third, machine power can be customized with special servers used to perform the processing duties and lower functioning, that is less expensive, workstation PCs used mostly for display purposes. As an example, all future servers may use a multitasking operating system like OS/2, Unix or some proprietary package. Multitasking allows many operations to be performed simultaneously, which can significantly improve the server's ability to handle many users at once. However, these operating systems require more expensive processors and much more memory. The more numerous workstation PCs on the other hand would not require this type of power.

Another advantage to the client server approach is the standardization of database systems. For example, different workstations on the network may run several different front-end application software programs but are able to use the same back-end application program on a single server. Another example would be different front-ends accessing information on different servers which use different back-end applications. This would be the ultimate in client-server flexibility. One approach to accomplish this is simply to standardize on the interface between the front-end and back-end software. IBM's STRUCTURED QUERY LANGUAGE (SQL) is an English-like database query language developed to provide a relatively simple method for entering, retrieving, and changing data in a database. It has become the standard database management tool.

SQL (sometimes pronounced Sequel), a query language developed by IBM in the 1970s, has been adopted by the majority of PC database vendors for getting information from relational databases. While most database servers support SQL, support for SQL does not make a product a databasae server. SQL is not a complete application development language but because of its strong query capabilities vendors are using it as an interface between the front-end and back-end, to link different databases on widely different machines, and to create some type of consistancy between database formats. Vendors will add there own special features to create their unique front-end and back-end products which talk to each other using standard SQL commands. Other vendors have created their own unique front-end and back-end programs using proprietary software and linkages that work equally as well. There is no standard for doing this today.

DATABASE SERVERS



ADVANTAGES

- MORE RELIABLE AND SECURE
- REDUCED PROGRAM AND DOCUMENT FILE TRAFFIC
- NO CONCURRENCY COMMANDS
- LESS EXPENSIVE HARDWARE FOR EACH WORKSTATION
- DEDICATE POWER TO SERVER MACHINE
- USE SPECIALIZED PROGRAMS AT SERVER

DATABASE SERVER SOFTWARE IS A SPECIALIZED FILE SERVER SOFTWARE WHICH SUPPORTS EFFICIENT ACCESS FOR MULTIPLE USERS OF ONE LARGE DATABASE.

STANDARD DATABASE ACCESS LANGUAGES AND PROCEDURES LIKE STRUCTURED QUERY LANGUAGE (SQL).

IBM'S MULTITASKING OS/2 OPERATING SYSTEM IS BETTER PREPARED TO HANDLE THE MULTIPLE, SIMULTANEOUS REQUESTS OF A DATABASE SERVER AND ABLE TO ADDRESS 16 MB OF MEMORY. UNIX BASED SUPPORT COMING ON STRONG NOW TOO.

THE CLIENT - SERVER MODEL

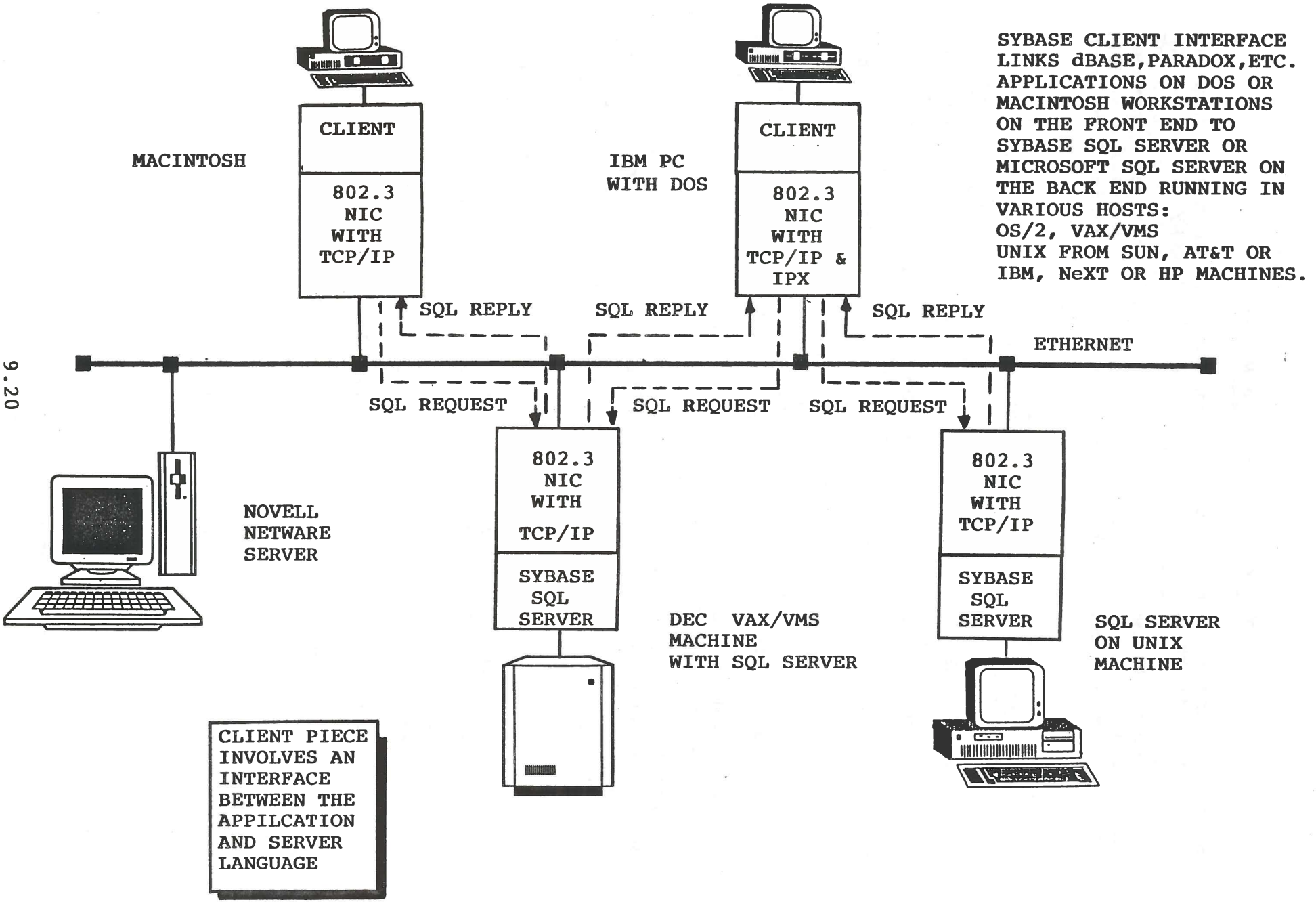
Even with the LAN smart applications, a copy of the program is transferred to the workstation PC along with a copy of the entire data file to be updated. This takes time and generates alot of traffic on the network. Moreover, other network traffic generated includes the concurrency control commands to lock various files and records as needed. Obviously, this is not the ideal network environment.

NETWORK applications are designed to actually share the processing power of computers on the network and represent a true distributed processing environment. Usually, although not always, this is done by dividing the applications into pieces. One piece is called the SERVER and runs in the server machine. The other is called the CLIENT and runs on the workstation PC. The client piece is the part that talks to you and the server piece does the data processing. Network applications that are divided into a client piece and server piece are said to follow the client-server model for distributed processing, which is not a new idea in the data processing world. The client piece, which runs in the worksatation PC, is usually called the FRONT-END program. The server piece is usually referred to as the BACK-END program. The back-end program resides in the server and handles requests for record access from several users at a time. One of the more common forms of client-server systems is the storage, manipulation, and retrieval of information or data.

A DATABASE SERVER, therefore, is a file server with special server application software that effectively supports database accesses in a client-server system. This is more of a special term used to discribe file access on a LAN.

A good example of this technique is as follows. An auto parts database contains thousands of records concerning the stock in a parts distributor's warehouse. There are several people in the warehouse who must fill orders for immediate delivery and others who must be sure there are enough parts on hand. One person asks to see a list of those parts which cost over $300 that are in stock. This request would be entered at the client workstation PC by the user. The front-end application software would format the request and transmit it over the network to the database server. The back-end application software then looks for all the parts over $300 that are in stock in the parts database. These records are then sent back to the front-end software which properly displays them on the user's screen.

UNIVERSAL DATABASE SERVER



SQL LAN DATABASE SOFTWARE

(SAMPLE LIST)

	COMPANY	PRODUCT	O/S SUPPORT	LAN NOS	SQL SUPPORT	DATABASE SERVER
1.	Ashton-Tate	dBASE IV	OS/2, DOS	MS-Net NetBIOS Netware 3+, 3+OPEN	Yes	SQL SERVER
2.	Borland	Paradox	OS/2,DOS	MS-NET NetBIOS Netware TOPS, VINES 3+	No	Oracle, SQL SERVER
3.	Information Builders	FOCUS	OS/2,DOS VMS, XENIX VM, VMS	VINES Netware 3+,3+OPEN MS-NET NetBIOS	Yes	Focnet, SQL SERVER
4.	Oracle	Oracle	OS/2, DOS XENIX, UNIX VMS, AU/X	Netware 3+	Yes	Oracle
5.	Revelation Technologies	Advanced Revelation	OS/2, DOS	MS-NET NetBIOS, Netware VINES 3+, 3+OPEN	Yes	NO
6.	Zanthe	Zim	DOS,QNX UNIX XENIX VMS,VM	Netware QNX MS-NET	Yes	Netware SQL

DATABASE SERVERS

	COMPANY	PRODUCT	OS SYSTEM	LAN TRANSPORT	MAXIMUM # DATABASES	MAXIMUM TABLES PER DATABASE
1.	Gupta Technologies	SQLBase	DOS, OS/2	NetBIOS Named Pipes	Unlimited	Unlimited
2.	IBM	IBM OS/2 EE DB Manager v.1.2	OS/2	NetBIOS Named Pipes	DASD	32767
3.	Microsoft	SQL Server	OS/2 LAN Manager	Named Pipes	32767	2 Billion
4.	Novell	Netware SQL	Netware 2.15+ OS/2 SPX	SPX		Unlimited
5.	Odesta	Multiuser Helix	Macintosh	Appletalk Ethernet	Unlimited	Unlimited
6.	VIA	VIA/DRE	DOS OS/2 EE	NetBIOS	Unlimited	Unlimited
7.	XDB Systems	XDB-Server	DOS, OS/2	NetBIOS	Unlimited	unlimited

DATABASE SOFTWARE BUYER'S GUIDE

Blyth Software
(415) 571-0222
Borland International Inc.
(408) 439-1060
Business Tools
(800) 648-6258
Caltex Software
(214) 522-9840
Data Access
(305) 238-0012
DataEase Intl.
(203) 374-8000
Fox Software
(419) 874-0162
Gupta Technologies
(415) 321-9500
Informix Software
(415) 926-6300
Micro Data Base Systems
(312) 303-6300
Microrim
(206) 885-2000
Microsoft
206-882-8080
Nantucket
(213) 301-4808
Novell
(512) 346-8380
Odesta
(312) 498-5615
Paperback Software Intl.
(415) 644-2116
Parameter Driven Software
(313) 540-4460
Progress Software
(617) 275-4500
Raima
(206) 747-5570
Revelation Technologies
(212) 689-1000
Sterling Software,
(613) 727-1397
VIA Information Systems
(609) 243-0433
WordTech Systems
(415) 254-0900
XDB Systems
(301) 779-6030

SERVER ARCHITECTURES

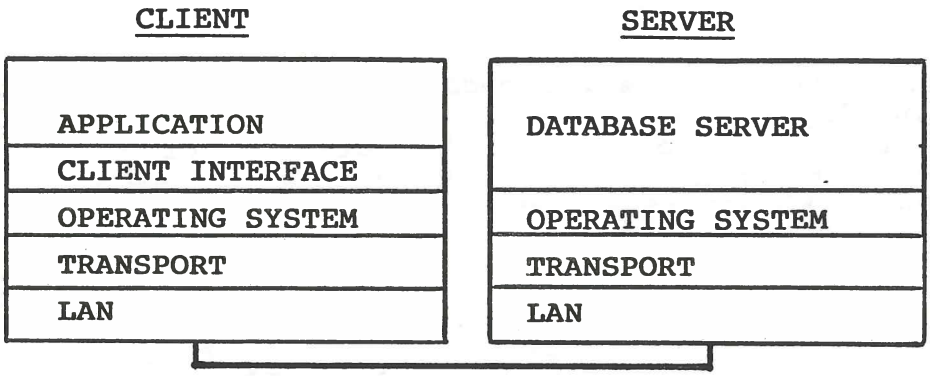
Typically, PC LAN SQL servers follow a standard model. There are several components or layers that work together so that the application software can communicate with the database server. Initially, the workstation application creates an SQL statement that it wants executed. The SQL statement may have been entered by the user, or the application could have created it internally based on menu selections the user entered. Now the client must pass the SQL command to the database server. To do this an SQL interface is used. This piece of code, supplied by the database server manufacturer, can take various forms. The interface code might be a library of function calls that are linked to an application. The interface might also be a terminate-and-stay-resident (TSR) piece of code. An SQL command from the client application is handed to the interface, which is then sent to the TRANSPORT layer where it is packetized and sent across the LAN via the appropriate NIC. In some situations, the transport layer is part of the workstation operating system, and in others it is provided as part of the LAN driver. Once the packets get to the server, they are passed up through the transport layer and the LAN interface to the operating system, the database server software receives the request.

Several firms are developing database gateways or converter programs that act as an interface translator. For example, an application might be written to the interface of a Sybase database. The request from the interface would be directed to the gateway, which would look like a Sybase server. Instead of executing the commands, the gateway software would make the equivalent call through a different interface to a non-Sybase server for execution. Another example is a PC on a Novell network makes a database request to the gateway program, which would not only translate the request to another SQL format but could send it out on a TCP/IP network link to a UNIX machine running the database server software.

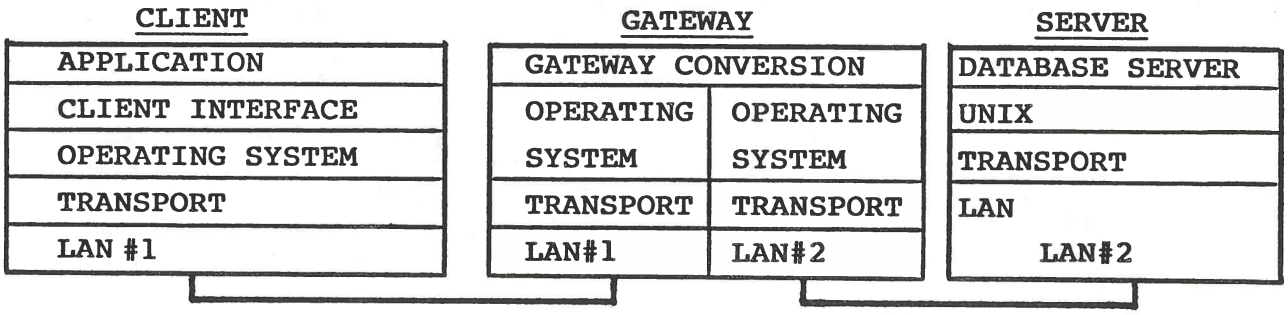
Until an industry-wide standard application interface is completed and adopted by vendors, these techniques provide only limited solutions to the ultimate, long term goal of providing access from any application to any database server. Today, and application written for one server must be modified, sometimes slightly and sometimes substantially, if it is to run with another server. The interface to one server might use function calls while another uses a precompiler. It doesn't matter whether you've used only the standard parts of SQL or not. If different vendor's server is used, there will be a different interface, and that will cause a rewrite.

SUPER SERVERS solve several problems for large LANs. First they provide high processing power, second they easily combine several LAN systems together, and third they are built to mainframe-like standards for physical structure and security.

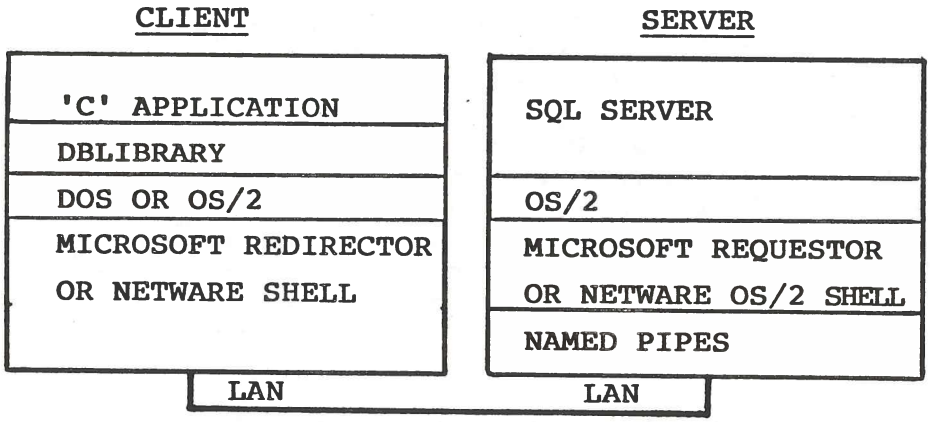
CLIENT-SERVER DATABASE COMPONENTS



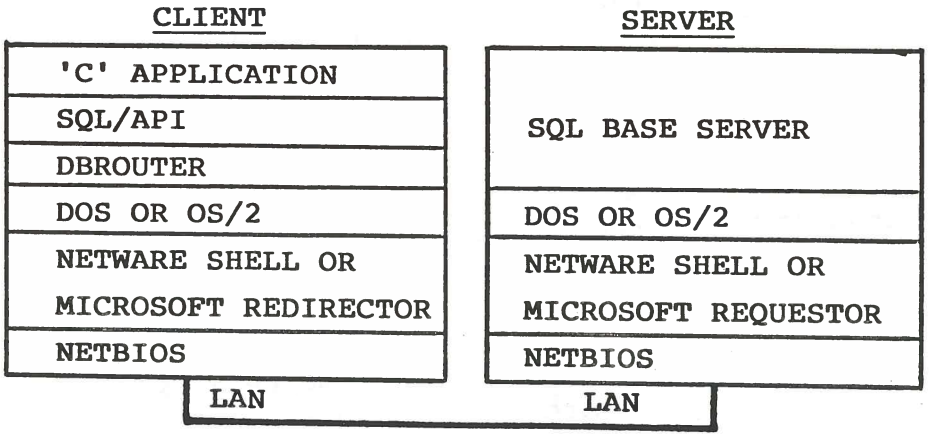
GENERAL STRUCTURE



GATEWAY STRUCTURE

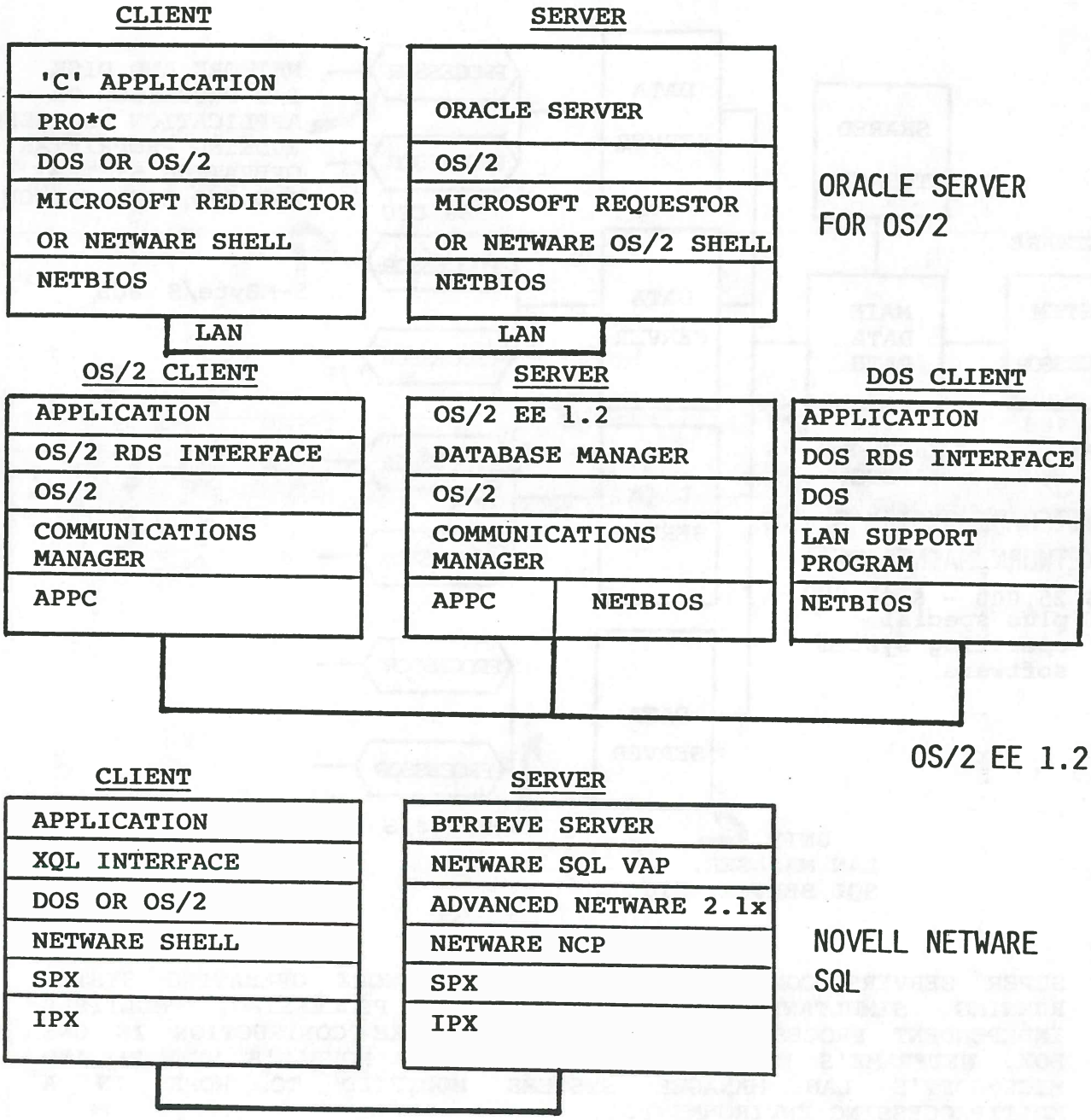


ASHTON-TATE/
MICROSOFT'S
SQL SERVER

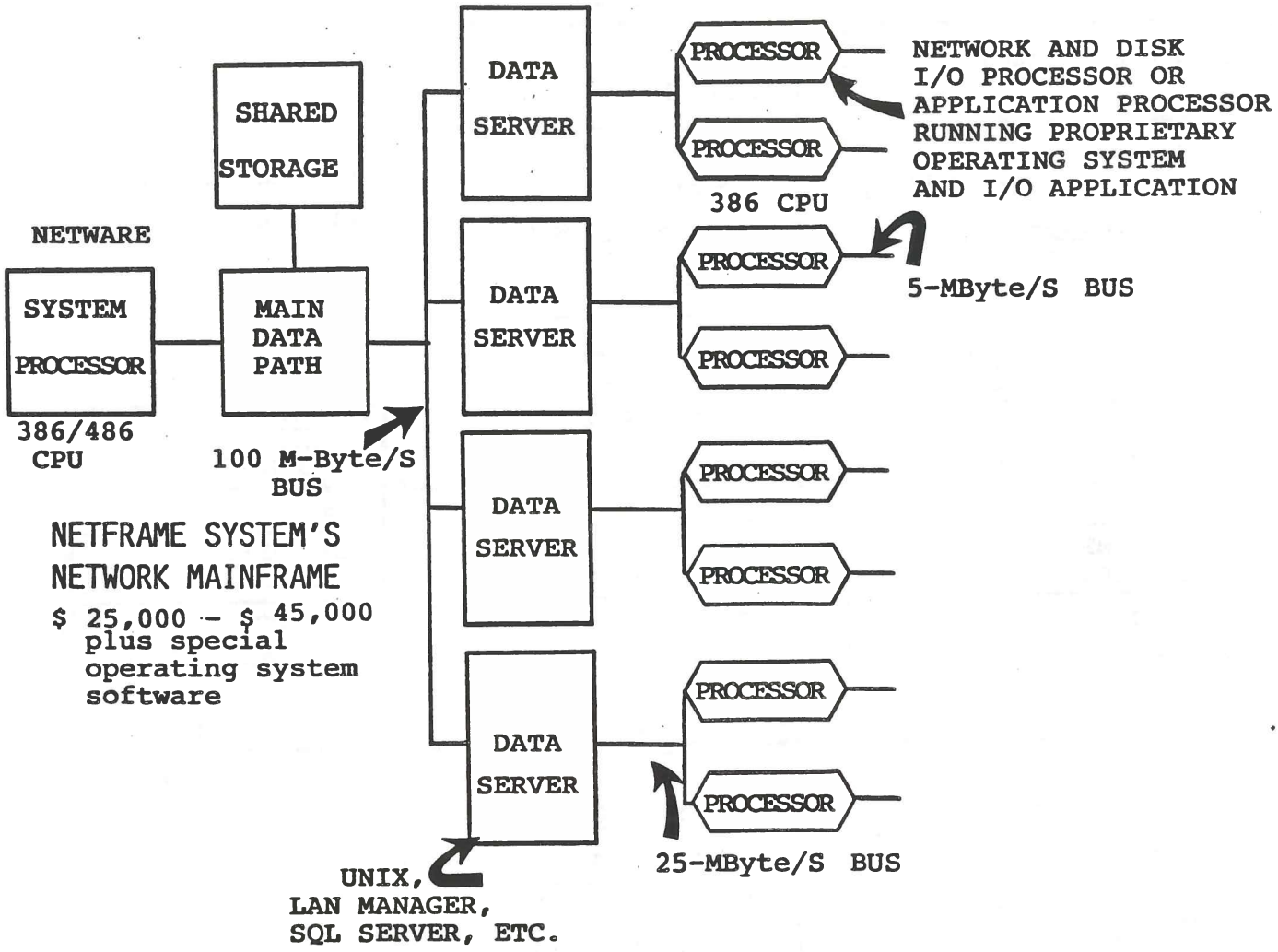


GUPTA
TECHNOLOGIES
SQL BASE

CLIENT-SERVER COMPONENTS



SUPER MULTILINGUAL SERVERS



SUPER SERVERS COMBINE MULTIPLE LAN NETWORK OPERATING SYSTEM RUNNING SIMULTANEOUSLY, HIGH SPEED PROCESSING, MULTIPLE INDEPENDENT PROCESSORS, AND MAINFRAME-LIKE CONTRUCTION IN ONE BOX. NETFRAME'S NFS-100 and NFS-300 RUN NOVELL'S NETWARE AND MICROSOFT'S LAN MANAGER SYSTEMS MODIFIED TO WORK IN A MULTIPROCESSING ENVIRONMENT.

OTHER VENDORS OF SUPER SERVERS INCLUDE:

AUSPEX SYSTEMS, INC. - UNIX AND ETHERNET SYSTEMS

AT&T'S STAR SERVER E

TANDEM/AT&T

COMPAQ COMPUTER CORP.

ZENITH DATA SYSTEMS

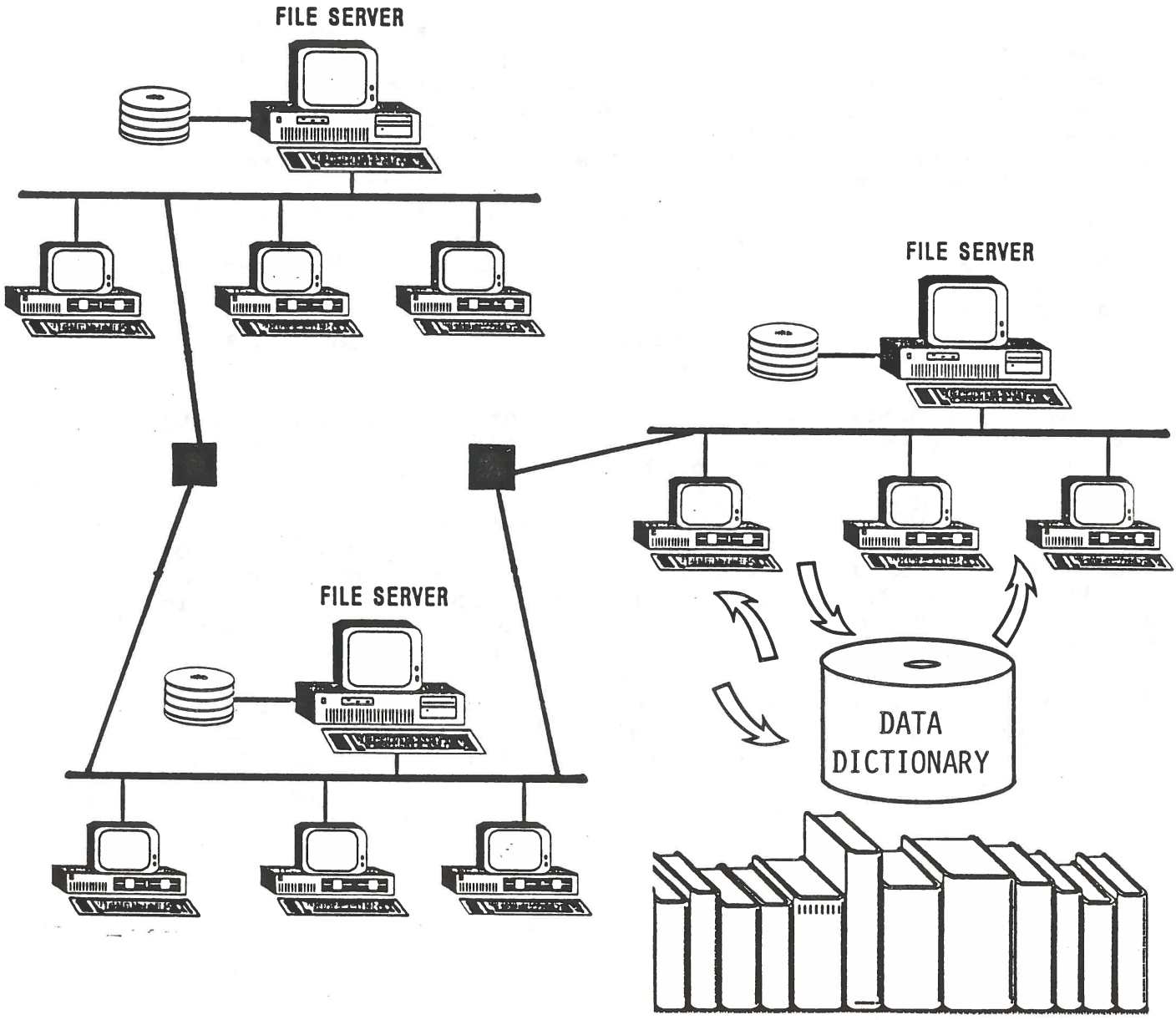
DISTRIBUTED DATABASES

Database servers and distributed databases are two different worlds, the latter being significantly more difficult to implement in a true fashion. A distributed database system has the ability to access multiple database nodes from within an application. Users should be able to do relational joins amoung tables residing on different servers. Another task is to write updates to two or more sites as part of one TRANSACTION. Many so called distributed databases require that the user specifies which database server he wants to access; however, a true distributed database system must be transparent to the user. The users should not have to give any location information. If the database manager decides to redistribute data to different servers, the front-end applications are not affected at all. The key to transparent access is DATA DICTIONARIES.

One important distributed database system is VIA DRE from VIA information Systems. It uses a dual data dictionary. Each database server operates independently, no master, and includes a dictionary discribing the data it holds. Each user has a dictionary handling application requests by connecting the user to the appropriate database server. The user dictionary knows where the data is so the application and the user need not. Data can be moved to the most convenient location without rewriting applications. The database manager sets up dictionaries to make the decisions about where to have the applications look.

VIA allows users to develop distributed database applications using a proprietary fourth generation language based on 'C'. It incorporates macros for building windowed, distributed applications.

DISTRIBUTED DATABASES



DISTRIBUTED DATABASE SYSTEM HAS MULTIPLE DATABASE NODES ON A VARIETY OF SERVERS LOCATED ANYWHERE.

- TRANSPARENT ACCESS FROM THE USER OR APPLICATION
- PERFORM RELATIONAL JOINS FROM DIFFERENT SERVERS
- WRITE UPDATES TO TWO OR MORE SITES PER ONE TRANSACTION
- DATA DICTIONARIES HOLD LOCATION INFORMATION
- APPLICATION/FRONT ENDS MUST KNOW HOW TO ACCESS DICTIONARY
- REQUEST IS THEN MADE TO THE APPROPRIATE SERVER

SECTION 10.

LAN MANAGEMENT

CASE STUDY

AIRLINE AIRPORT SYSTEMS

Four hundred United Airline planes take off and land at O'Hare airport each day. Information critical to flights changes fast and constantly and is updated locally from the airport and from sites across the country. United needed an airport system that could keep abreast of rapidly changing information supporting 2000 user devices over four unique applications. PCs, LANs and distributed processing was the answer. The ultimate network had to provide access to two mainframe based systems - the Apollo worldwide reservations system and the flight operation system which is used for accessing departure times, crew schedules, fueling, baggage handling, and gate assignment information. These mainframes support four airport systems - Gate Assignment Display, Flight Information Display (900 monitors), Baggage Display, and Customer Information Display (300 microprocessor based signs).

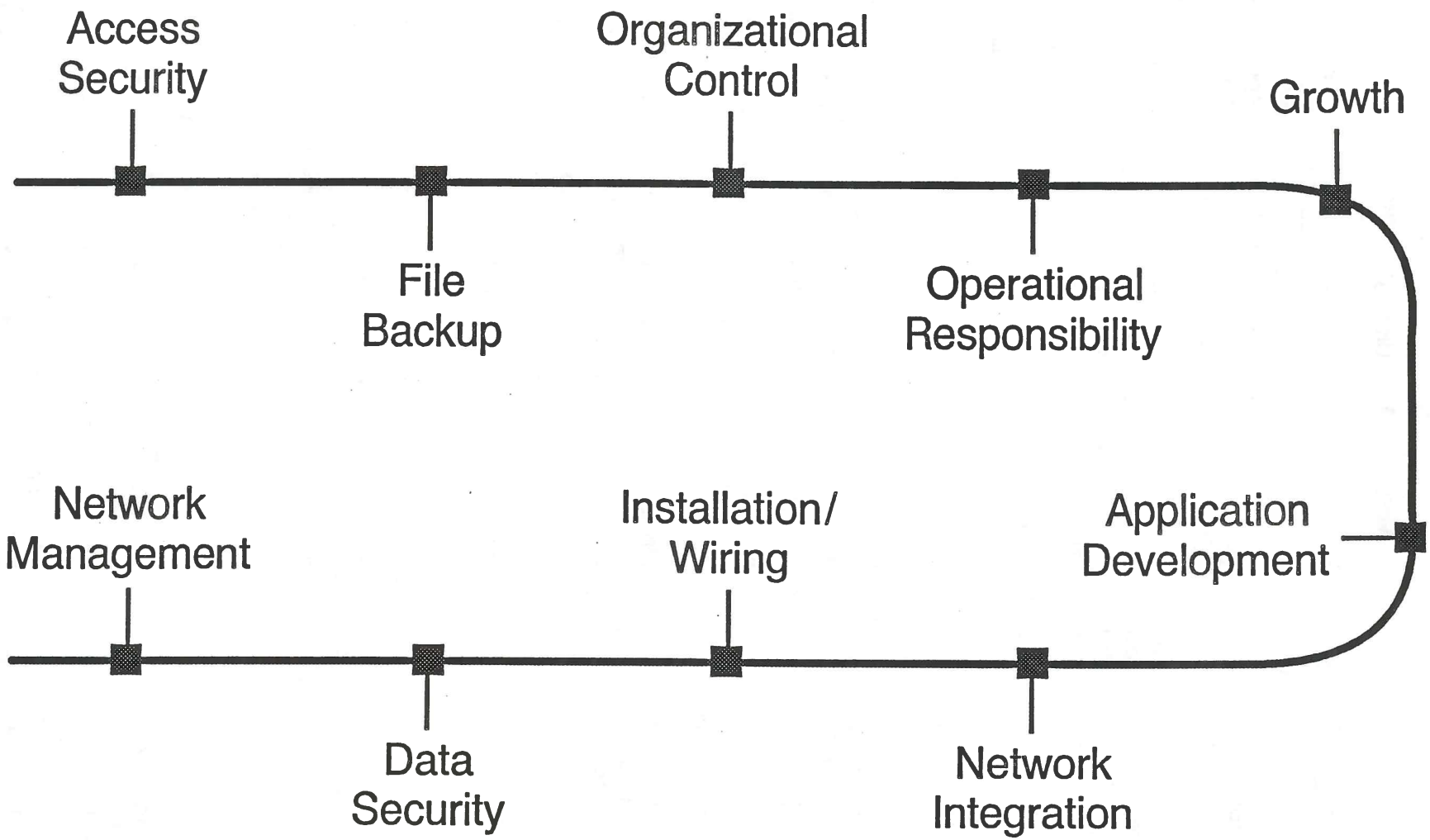
United found that no single vendor could serve all its automation needs and wound up with different vendors for each component of the network, from video monitors to intelligent keypads. The users' workstations are IBM PS/2 model 50 equiped with Token Ring boot ROM chips so they can run diskless. The PCs are connected to a 2,000 node Token Ring LAN which consists of four backbone rings and 23 logical subrings on 10 miles of IBM type 2 cable. A smaller Ethernet network is used to control the gate assignment system as the unique application providing this service was built exclusively for an Ethernet network.

Both Ethernet and Token Ring networks are connected to the host systems through Texas Instrument SNA gateways over 1.544M bps T-1 links. The gateway machines, Texas Instrument PCs, house intelligent communications adapters and Token Ring adapters. Each gateway can support 64 logical LAN devices. The users always see a Microsoft Windows interface. Users can open up to 32 windows at once, but usually use no more than four.

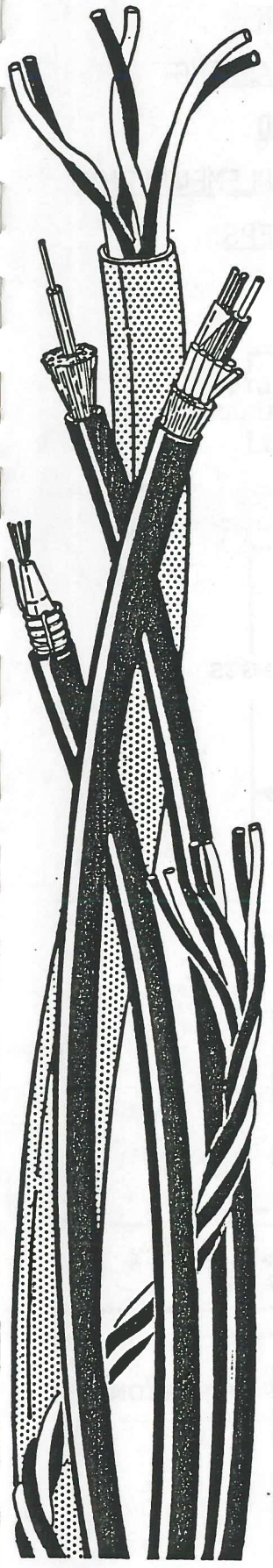
An interesting application is the Flight Information Display System (FIDS) which controls the 900 monitors that passengers see in the terminal and the operation monitors that display fuel and maintenance information to the ground service crews. Flight information is stored in several PS/2 model 80s each with 2 MB of memory and 70 MB hard disk drives. Flight information is distributed over the Token Ring network to all these monitors for passengers, service crews, gate controllers and baggage handlers via monitors and PC windows.

The Customer Information Display System (CIDS) uses information from FIDS uses electronic signs to display everything from baggage notices to promotional messages. The signs have 80186 processors built in and communicate with I/O servers attached to the LAN which convert messages to the proper format and pass them along to the signs. FIDS is run from a central processor at O'Hare and updated with information entered at workstations attached to the Token Ring. CIDS and other applications are run in user's workstations with the appropriate modules and files downloaded from the server, with shared files updated afterward.

LAN Management Issues



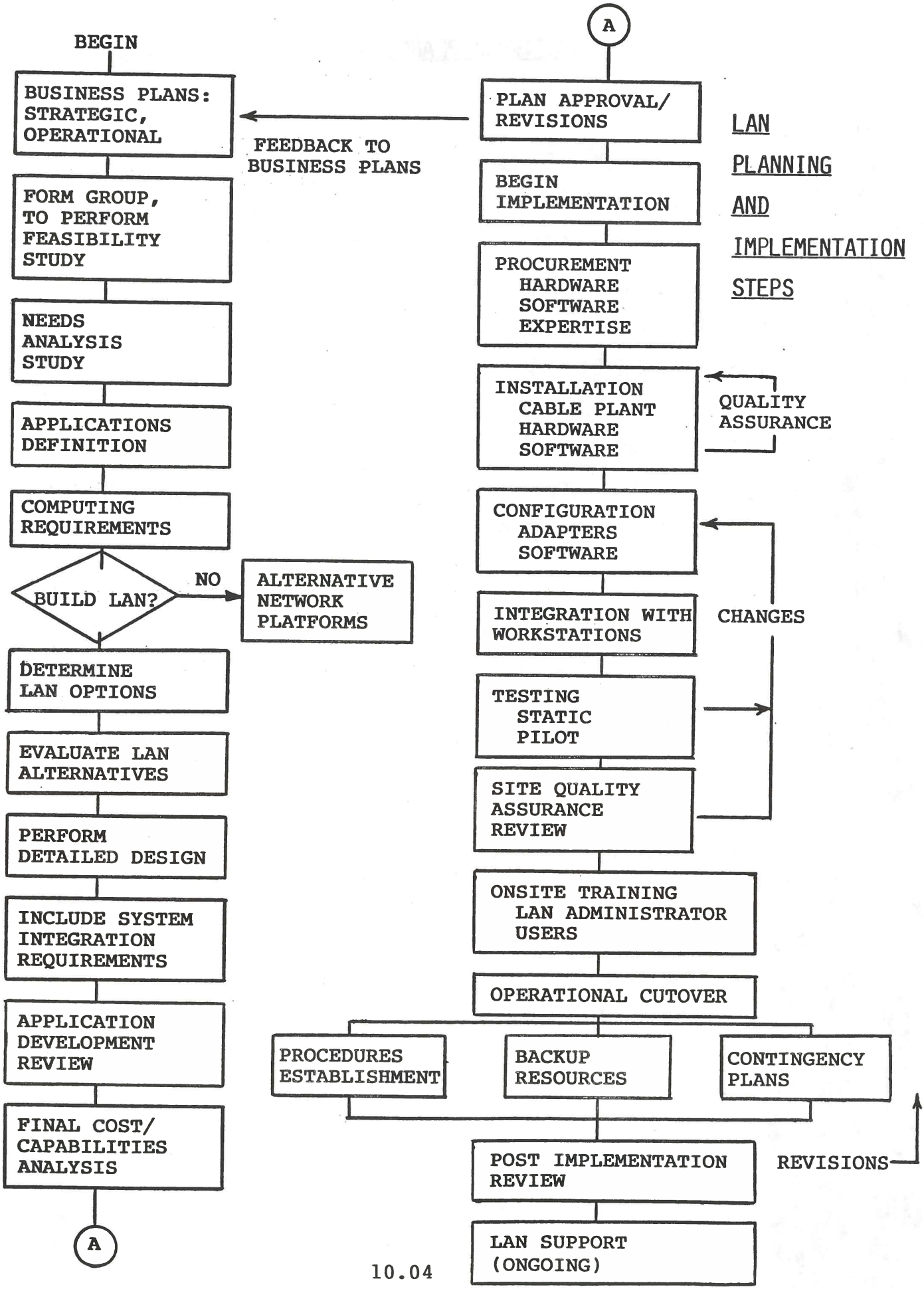
LAN NETWORK PLANNING



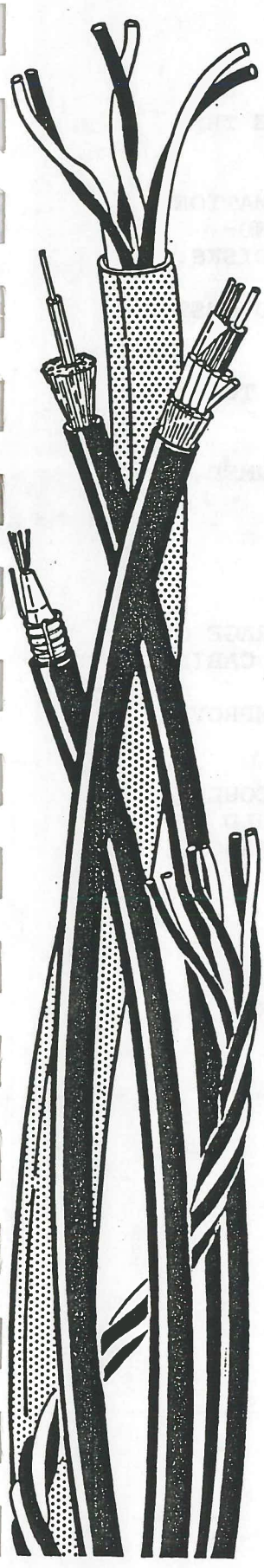
1. INVENTORY THE RESOURCES
2. IDENTIFY THE USERS
3. NETWORK OBJECTIVES
4. NETWORK APPLICATIONS
5. NETWORK HARDWARE
6. NETWORK SIZING
7. SYSTEM TESTING
8. COMPONENT LABELING
9. DOCUMENTATION
10. ON-GOING MANAGEMENT

LAN MANAGER DUTIES

1. ADDRESS ADMINISTRATION
2. OTHER IDENTIFICATION
3. DISK MANAGEMENT
4. DISK BACKUP
5. FRONT-END PROGRAMS
6. SECURITY
7. PERFORMANCE MONITORING
8. END USER HELP
9. TROUBLESHOOTING


BEGIN
BUSINESS PLANS: STRATEGIC, OPERATIONAL
FEEDBACK TO BUSINESS PLANS
FORM GROUP, TO PERFORM FEASIBILITY STUDY
NEEDS ANALYSIS STUDY
APPLICATIONS DEFINITION
COMPUTING REQUIREMENTS
BUILD LAN?
NO
ALTERNATIVE NETWORK PLATFORMS
DETERMINE LAN OPTIONS
EVALUATE LAN ALTERNATIVES
PERFORM DETAILED DESIGN
INCLUDE SYSTEM INTEGRATION REQUIREMENTS
APPLICATION DEVELOPMENT REVIEW
FINAL COST/ CAPABILITIES ANALYSIS
A
A
PLAN APPROVAL/ REVISIONS
BEGIN IMPLEMENTATION
PROCUREMENT
HARDWARE
SOFTWARE
EXPERTISE
INSTALLATION
CABLE PLANT
HARDWARE
SOFTWARE
QUALITY ASSURANCE
CONFIGURATION
ADAPTERS
SOFTWARE
INTEGRATION WITH WORKSTATIONS
CHANGES
TESTING
STATIC
PILOT
SITE QUALITY ASSURANCE REVIEW
ONSITE TRAINING
LAN ADMINISTRATOR
USERS
OPERATIONAL CUTOVER
PROCEDURES ESTABLISHMENT
BACKUP RESOURCES
CONTINGENCY PLANS
POST IMPLEMENTATION REVIEW
REVISIONS
LAN SUPPORT (ONGOING)
LAN PLANNING AND IMPLEMENTATION STEPS

NETWORK PLANNING



1. INVENTORY THE RESOURCES:

- PLAN ON HAVING ALL APPLICATIONS RUNNING ON ALL WORKSTATIONS.

- WORKSTATION DOCUMENTATION

  - SOFTWARE CONFIGURATION FILES
  - DOS (O/S) VERSION
  - MANUFACTURER
  - MONITOR TYPE
  - GRAPHICS CAPABILITY
  - LAST DRIVE USED BY LOCAL HARD DISKS

- IDENTIFY POTENTIAL SERVERS AND SPECIALIZED PCs THAT WILL BE USED FOR DISK, PRINTER, COMMUNICATIONS, DATABASE OR OTHER SERVICES.

  - HARDWARE CONFIGURATION
  - PHYSICAL LOCATION
  - DEDICATED OR SHARED USE

- SKETCH FLOOR PLAN TO BE USED/MODIFIED LATER FOR NETWORK LAYOUT

2. IDENTIFY THE USERS:

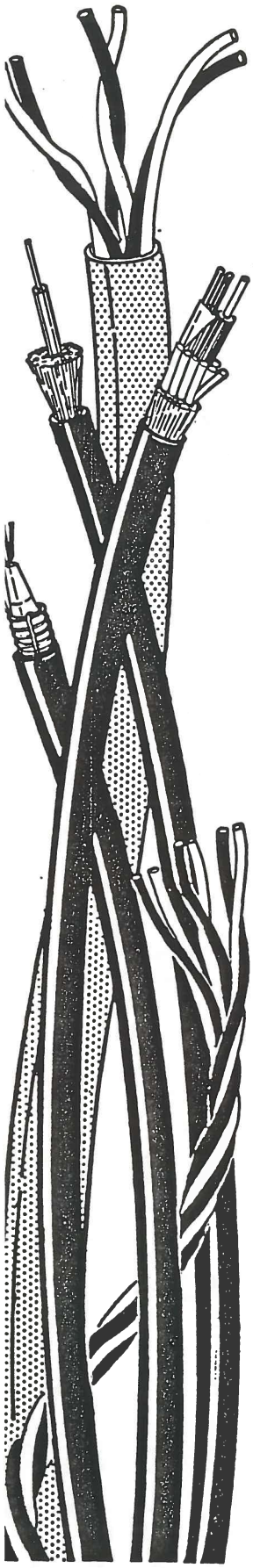
- IDENTIFY EACH USER YOU WILL ASSIGN A LOGIN ID

  - USER'S PC BACKGROUND AND EDUCATIONAL REQUIREMENTS SHOULD BE NOTED FOR ASSESSING TRAINING NEEDS LATER.

  - PLAN FOR TEMPORARY USERS SUCH AS GUESTS, SUPERVISORS, TRAINEES, ETC. AND THEIR RIGHTS TO FILES AND APPLICATIONS.

  - TRY TO LIST USERS AS PART OF A GROUP WHICH MAKES IT EASIER TO ADMINISTER DIRECTORY RIGHTS AND LOGIN RESTRICTIONS, BUT LIMIT THE NUMBER OF EXCEPTIONS WITHIN THE GROUP.

NETWORK PLANNING



3. NETWORK OBJECTIVES:

° WHAT TASKS ARE CURRENTLY PERFORMED AND HOW ARE THEY ACCOMPLISHED, SUCH AS:

- ACCOUNTING, BILLING , INVENTORY, ETC. INFORMATION MAYBE SHARED BY DEPARTMENTS CURRENTLY BY HAND-CARRYING FILES AROUND THE OFFICE ON FLOPPY DISKS.
- CHECKS AND SALES ORDERS ARE HAND WRITTEN AND MUST BE ENTERED MANUALLY INTO THE SYSTEM.
- PRINTERS, PLOTTERS AND MODEMS ARE DEDICATED TO A SINGLE APPLICATION.

° WHAT TASKS ARE NEEDED BUT NOT CURRENTLY PERFORMED, SUCH AS:

- DATA FILES NEED TO BE TRANSFERRED TO A HOST COMPUTER IN ANOTHER CITY.
- USE OF ELECTRONIC MAIL OR MESSAGING AND STORAGE OF HAND WRITTEN MEMOS WHICH ARE KEPT IN A FILE CABINET.

° WHAT TECHNIQUES OR PROCEDURAL CHANGES WOULD IMPROVE A BUSINESS FUNCTION, SUCH AS:

- SIGNIFICANT IMPROVEMENTS TO DELIVERY DATES COULD BE ACHIEVED IF ALL PROJECTS TEAM MEMBERS COULD BE MADE AWARE OF THE IMMEDIATE STATUS OF ANY CHANGES, COMPLETIONS, OR MODIFICATIONS TO A PROJECT PLANNING SCHEDULE.

° WHAT INFORMATION DOES NOT GET RECEIVED.

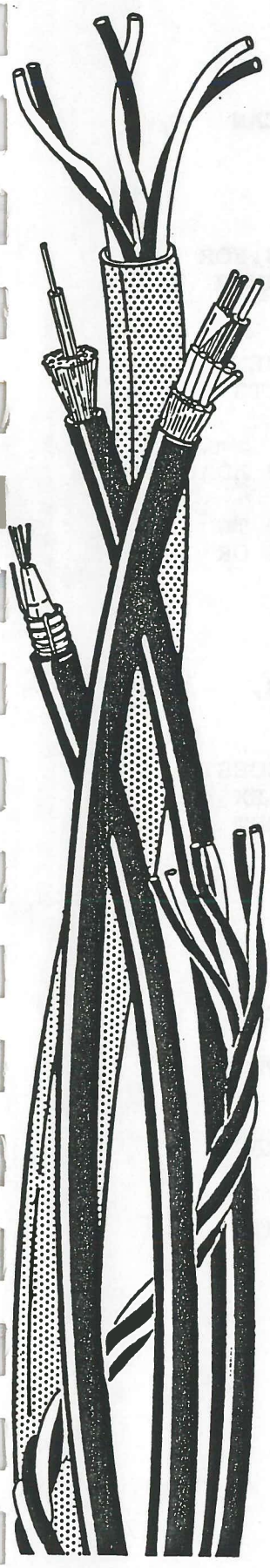
° WHAT INFORMATION CURRENTLY OBTAINED AT REGULAR INTERVALS COULD BE USED MORE FREQUENTLY.

° WHAT INFORMATION RECEIVED WOULD BE MORE USEFUL IF IT WERE MORE TIMELY.

° WHAT INFORMATION IS NOT SHARED WITH OTHERS.

° WHAT INFORMATION IS MISSING.

° WHAT INFORMATION TAKES A LONG TIME TO FIND.



4. NETWORK APPLICATIONS:

° SELECTING THE RIGHT APPLICATIONS CAN IMPROVE PRODUCTIVITY, INCREASE USER SATISFACTION, AND GIVE THE COMPANY MEANINGFUL AND MEASURABLE COMPETITIVE EDGE.

° BUY PROVEN PERFORMERS; LEADING EDGE BUT NOT BLEEDING EDGE PRODUCTS.

° DEFINE USER NEEDS:

- IDENTIFY REQUIRED FEATURES AND WISH LISTS.

- HAVE A CLEAR PICTURE OF WHAT SUCCESS LOOKS LIKE.

° EVALUATE BASED ON:

- FUNCTIONALITY
- FEATURES
- EASE OF USE
- FLEXIBILITY
- RELIABILITY
- PERFORMANCE
- SUPPORT
- NETWORK COMPATIBILITY

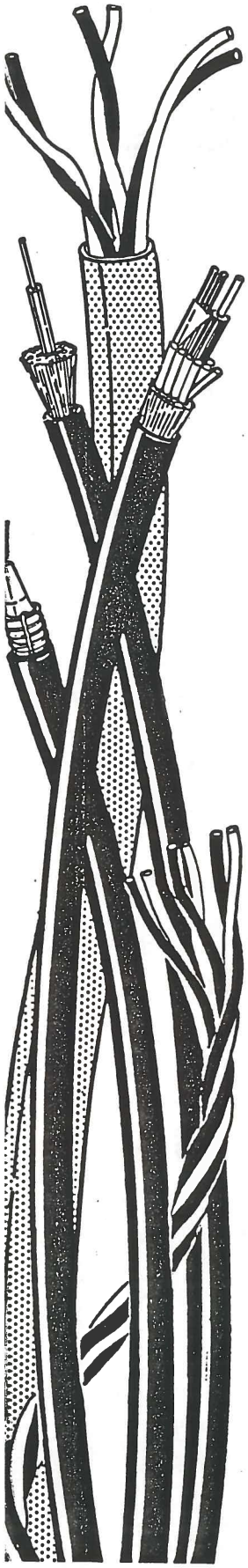
° NETWORK COMPATIBILITY: MOST VENDOR CLAIMS MAY BE TRUE FOR MOST SYSTEMS; HOWEVER, THERE ARE TOO MANY:

- DOS (O/S) VERSIONS
- NETWORK O/S VERSIONS
- MOUSE DRIVERS
- MONITORS
- ADAPTERS (NICs)
- AMOUNTS OF AVAILABLE RAM
- TSRs (TERMINATE AND STAY RESIDENT) PROGRAMS SUCH AS SIDEKICK, OR KEYBOARD-MAPPING ROUTINES.

° NETWORK "AWARE" SOFTWARE GENERALLY PROVIDES BETTER RESULTS THAN SOFTWARE THAT ISN'T. NETWORK "IGNORANT" APPLICATIONS WON'T TAKE ADVANTAGE OF NETWORK FEATURES, CAN CAUSE ADMINISTRATIVE NIGHTMARES, AND MAY EXPOSE DATA TO RISK.

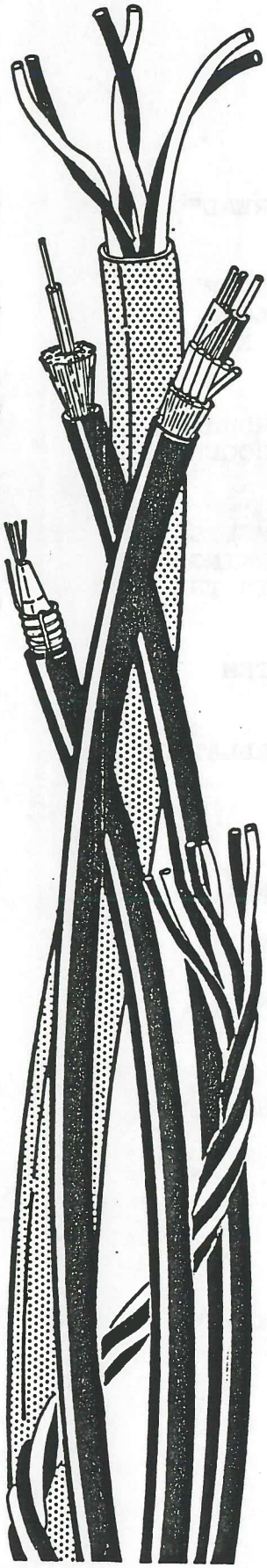
° APPLICATIONS SHOULD HAVE NETWORK LICENSES FOR A SITE, FOR A SERVER, OR A CERTAIN NUMBER OF SIMULTANEOUS ACCESSES. AVOID PURCHASES THAT ARE BASED ON WORKSTATION COUNT.

NETWORK PLANNING



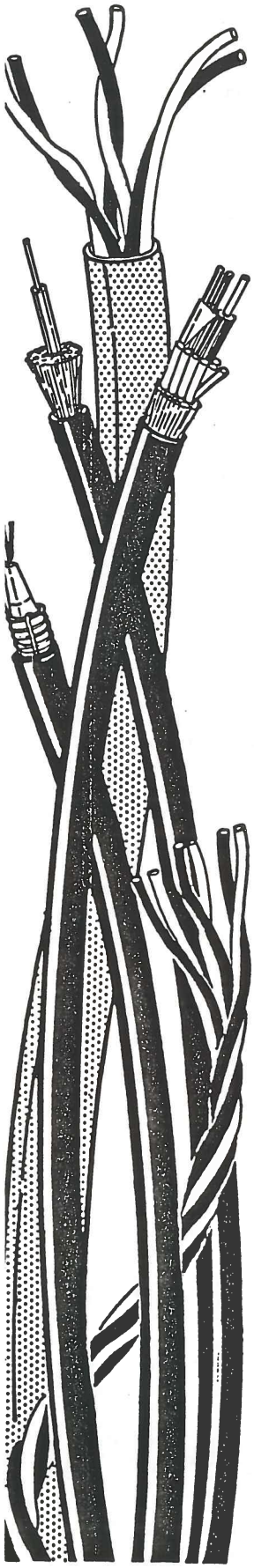
5. NETWORK HARDWARE:

- NOTE EXISTING EQUIPMENT USAGE AND WHETHER IT CAN BE USED/REUSED IN THE NETWORK.
- NEW EQUIPMENT DETERMINATION.
  - DEVICES REQUIRED BY THE APPLICATION PROGRAMS,FOR DATA STORAGE, FOR NETWORK UTILITIES, FOR SERVER FUNCTIONS, ETC.
  - NUMBER AND TYPES OF ADAPTER CARDS OR ATTACHMENT FEATURES REQUIRED BY EACH DEVICE THAT CONNECTS DIRECTLY TO ONE OR MORE LAN SEGMENTS.
  - THE CONNECTION POINT TO THE NETWORK FOR EACH ADAPTER.
  - CONVERSION OR REGENERATION COMPONENTS NEEDED TO EXTEND THE ALLOWED DISTANCE BETWEEN DEVICES OR COONECTION POINTS.
  - ROUTERS, BRIDGES OR GATEWAY PRODUCTS.
  - REMOTE COMMUNICATIONS DEVICES SUCH AS MODEMS, TRANSMISSION LINES, MULTIPLEXERS, ETC.
  - SUPPORT PROGRAMS FOR ADAPTERS, DRIVERS: BRIDGES AND ROUTERS, SERVERS AND GATEWAYS IN A COMPLEX NETWORK SHOULD HAVE NETWORK MANAGEMENT SUPPORT FEATURES.
- ESTABLISH NEED FOR PERIPHERAL EQUIPMENT
  - PRINTERS AND PLOTTERS BY TYPE AND FEATURES.
  - TAPE DRIVES AND OTHER DATA/FILE BACKUP DEVICES.
  - UPS - UNINTERRUPTABLE POWER SUPPLIES AND SUPPORT PROGRAMS/FEATURES FOR THE ENVIRONMENT.
  - REDUNDANT COMPONENTS/SYSTEMS FOR FAULT TOLERANT SYSTEM DESIGN.
  - SPARE PARTS ON HAND, SUPPLIERS OF PARTS WITHIN VERY SHORT LEAD TIMES TO REDUCE DOWN TIME.



6. NETWORK SIZING:

- A SINGLE LAN SEGMENT USUALLY HAS A MAXIMUM NUMBER OF DEVICES.
- BRIDGES CONNECT LAN SEGMENTS BUT MAY SLOW DOWN ACCESS TO OFTEN USED COMPONENTS SUCH AS SERVERS OR CREATE DELAY PROBLEMS WHEN USING TIME DEPENDENT APPLICATIONS OR PROTOCOLS. SOME BRIDGE SYSTEMS LIMIT THE NUMBER THAT A PACKET CAN TRAVERSE TO SEVEN.
- LAN SEGMENTS MAY BE CREATED BASED UPON GROUPING OF WORKSTATIONS BY TASK OR FUNCTION OR BY GEOGRAPHICAL LOCATION.
- CREATE LAN SEGMENTS WITH ROOM FOR GROWTH OF ATTACHED DEVICES.
- A CENTRALLY LOCATED LAN BACKBONE SEGMENT PROVIDES FOR WIDE ACCESS OF SERVERS, PRINTERS, GATEWAYS, ETC. WITH MINIMUM DELAY THROUGH BRIDGES.
- CABLE RUNS MAY BE DICTATED BY BUILDING DESIGN, BUILDING WIRING DESIGN OR OTHER RESTRICTIONS WHICH HAVE TO BE TAKEN INTO CONSIDERATION.
- SOME GATEWAY DEVICES ACCEPT INFORMATION FORMATTED FOR ONLY ONE PROTOCOL OR INTERFACE.
- REMOTE COMMUNICATION LINKS OPERATE MUCH SLOWER THAN LAN SEGMENTS, EVEN T1 CARRIER LINKS OPERATE AT 1,544,000 bps COMPARED TO COMMON LAN RATES OF 4, 10, OR 16 MILLION bps, WHICH CAN BECOME A BOTTLENECK.



7. SYSTEM TESTING

° PILOT SYSTEM.

- CREATE A SMALL TEST VERSION OF THE NETWORK AS A PILOT INSTALLATION BEFORE ANY OF THE "REAL" AND COMPLETED SYSTEM IS INSTALLED.

- THE DIFFERENCE BETWEEN A PILOT AND THE FIRST OF MANY IS THAT THE IMPLEMENTATION SCHEDULE ALLOWS FOR TIME AFTER THE PILOT TO FIX PROBLEMS OR EVEN REDESIGN THE NETWORK.

- A PILOT SHOULD EXERCISE ALL OF THE BASIC HARDWARE, SOFTWARE AND INSTALLATION AND OPERATIONAL PROCEDURES WITH REAL PEOPLE AND DATA.

- A PILOT ESTABLISHES WHETHER THE SYSTEM MEETS THE OBJECTIVES EVEN IF ALL THE PARTS ARE WORKING OR IF EXISTING, WORKING EQUIPMENT PERFORMS IN THE NEW ENVIRONMENT.

° TEST-BED NETWORK IS A SEPARATE, SMALL LAN SYSTEM USED ON AN ON-GOING BASIS TO TEST COMPONENTS.

- TEST NEW OR MODIFIED SOFTWARE PRIOR TO INSTALLATION ON PRIMARY NETWORK.

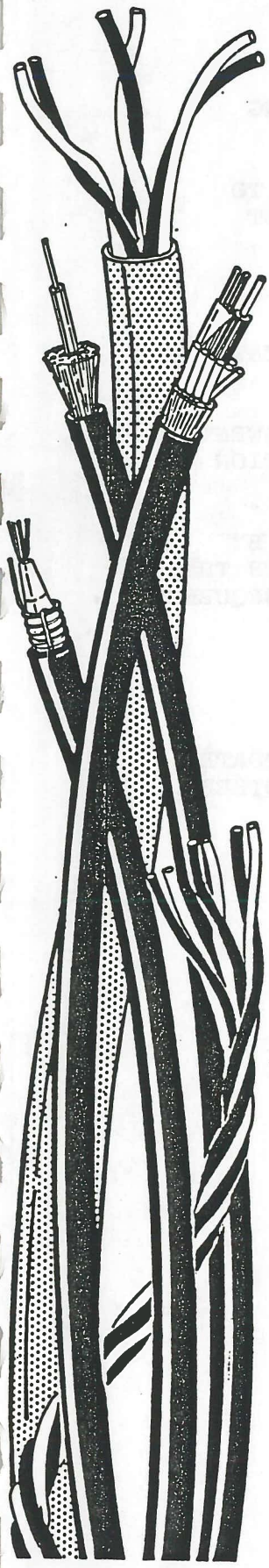
- USED TO VERIFY TEST PROCEDURES.

- CREATE AND VERIFY USER OPERATIONAL PROCEDURES.

- USER AND OPERATOR TRAINING AND DEMONSTRATIONS.

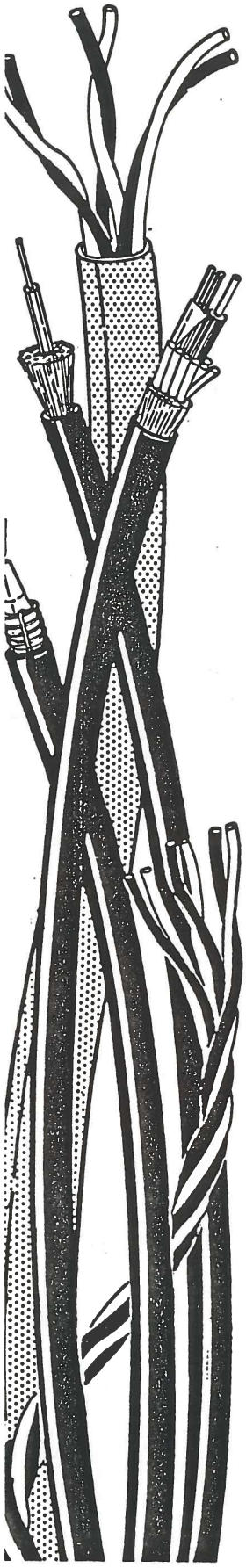
- ASSIST WITH PROBLEM RESOLUTION/SIMULATION OR SOLUTION TESTING.

° BURN-IN TESTING OF ALL HARDWARE COMPONENTS BY RUNNING THEM (POWERED-ON) FOR 48 HOURS CONTINUOUSLY BEFORE INSTALLED IN NETWORK.



8. COMPONENT LABELING:

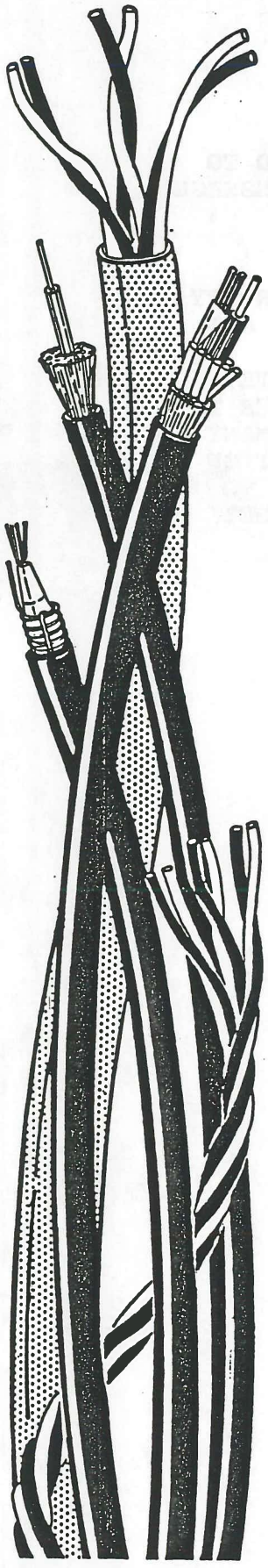
- RECORD NUMBER AND NAMES IDENTIFYING THE DEVICES AND CABLE CONNECTIONS IN THE NETWORK ALONG WITH THE PHYSICAL LOCATIONS OF THE COMPONENTS.
- USE UNIQUE AND MEANINGFUL IDENTIFICATION, WHICH SHOULD ALLOW YOU TO DETERMINE QUICKLY:
  - LOCATION (ROOM, OFFICE, FLOOR)
  - TYPE OF COMPONENT
  - TYPE OF INSTALLATION (RACK, ADAPTER IN COMPUTER, FACEPLATE, CONNECTOR, NETWORK CONNECTION POINT, ETC.)
- IDENTIFY CONNECTION POINT AT BOTH ENDS OF EACH CABLE USED IN THE NETWORK; BUILDING WIRE, PATCH CABLES, ADAPTER CABLES, OR OTHER PHYSICAL MEDIA.
- USE LABELING SCHEME ON COMPONENTS THEMSELVES AND TO IDENTIFY COMPONENTS ON THE CHARTS AND WORKSHEETS IN THE DOCUMENTATION.



9. DOCUMENTATION:

- MAINTAIN CHARTS AND OTHER DOCUMENTATION SHOWING PHYSICAL LAYOUT OF NETWORK.
- THERE ARE SOFTWARE UTILITY PACKAGES AVAILABLE TO ASSIST WITH DOCUMENTATION AND CHANGE MANAGEMENT FOR LANS.
- IMPORTANT ITEMS TO INCLUDE.
  - CONTENTS OF EQUIPMENT RACKS AND TELECOMMUNICATIONS CLOSETS.
  - SEQUENCE IN WHICH DEVICES AND HARDWARE COMPONENTS ARE CABLED TOGETHER INCLUDING PHYSICAL LOCATION OF CABLES AND CONNECTION POINTS.
  - NAMES, ADDRESSES AND OTHER IDENTIFIERS USED BY DEVICES, COMPONENTS AND PROGRAMS MATCHED WITH THEIR PHYSICAL LOCATIONS - ONE LIST IN IDETIFIER SEQUENCE AND THE OTHER LIST IN LOCATION SEQUENCE.
  - EQUIPMENT ORDERING AND INVENTORY WORKSHEETS FOR ORIGINAL AND REPLACEMENT PARTS.
  - STORAGE OF ALL PRODUCT DOCUMENTATION WITH UPDATES, RELEASES, PRODUCT MODIFICATION NOTICES AND OTHER VENDOR PUBLICATIONS BY PRODUCT TYPE.

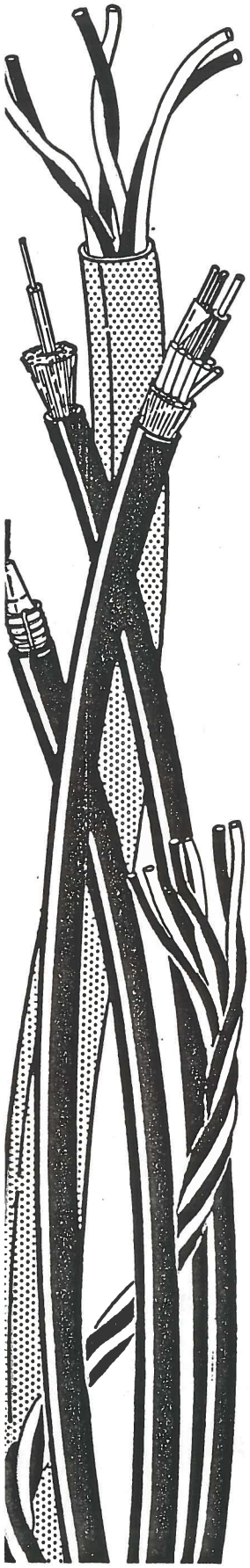
LAN MANAGER DUTIES



1. ADDRESS ADMINISTRATION

- DETERMINE WHETHER TO USE UNIVERSALLY OR LOCALLY ADMINISTERED ADAPTER ADDRESSES.
- DETERMINE THE FORMATS AND VALID VALUES FOR THE ADDRESSES AND FEATURES.
  - THOSE THAT REQUIRE OTHER THAN 12 HEX DIGITS FOR THE ADAPTER.
  - FORMATS AND CONVENTIONS REQUIRED FOR NAMES AND ADDRESSES USED BY APPLICATION PROGRAMS, SUPPORT PROGRAMS AND INTERFACES USED TO COMMUNICATE WITH OTHER NETWORKS.
- CREATE GUIDELINES AND PROCEDURES FOR CHANGING NAMES AND ADDRESSES AND UPDATING DOCUMENTATION.
- ANTICIPATE FUTURE NETWORK GROWTH AND CHANGE AS ADDRESSES AND NAMES ARE ASSIGNED. FOR EXAMPLE:
  - NAMES/ADDRESSES THAT ARE DEPENDENT UPON LOCATION OR LAN SEGMENT MAY HAVE TO BE CHANGED IN THE FUTURE.
  - LOCALLY ADMINISTERED ADDRESSES MAYBE ASSIGNED VALUES WITHIN A RANGE WHICH CAN BE IDENTIFIED EASILY, I.E. ACCOUNTING DEPARTMENT 00050-00100.
  - ASSIGN SEQUENTIAL VALUES TO RELATED ADAPTER TYPES.
  - LOCALLY ADMINISTERED ALLOW FOR RETAINING THE SAME ADDRESS FOR REPLACEMENT ADAPTERS AND THEREBY AVOID MODIFYING SOFTWARE PROGRAMS THAT MUST USE ADAPTER ADDRESSES DIRECTLY.
  - LOCALLY ADMINISTERED ALLOW FOR RANGES OF ADDRESSES TO BE INCLUDED OR EXCLUDED BY FILTERING PROGRAMS WHICH DECIDE WHETHER A FRAME SHOULD BE FORWARDED THROUGH A BRIDGE OR ROUTER.
  - UNIVERSALLY ADMINISTERED ADDRESSES CAN NOT BE OBTAINED UNTIL ADAPTERS ARE INSTALLED USING THE ADAPTER DIAGNOSTIC TEST ROUTINE.
  - LOCALLY ADMINISTERED ADDRESSES ARE SPECIFIED AS A PROGRAM OR INTERFACE LOAD OR CONFIGURATION PARAMETER.
- GROUP ADDRESSES ALLOW A PROGRAM TO SEND A BROADCAST MESSAGE THAT WILL BE RECEIVED BY ALL DEVICES WITH THE SAME GROUP ADDRESS. EACH PROGRAM THAT EXPECTS TO RECEIVE GROUP MESSAGES MUST ENABLE THE GROUP ADDRESS ON ITS ADAPTER.

LAN MANAGER DUTIES



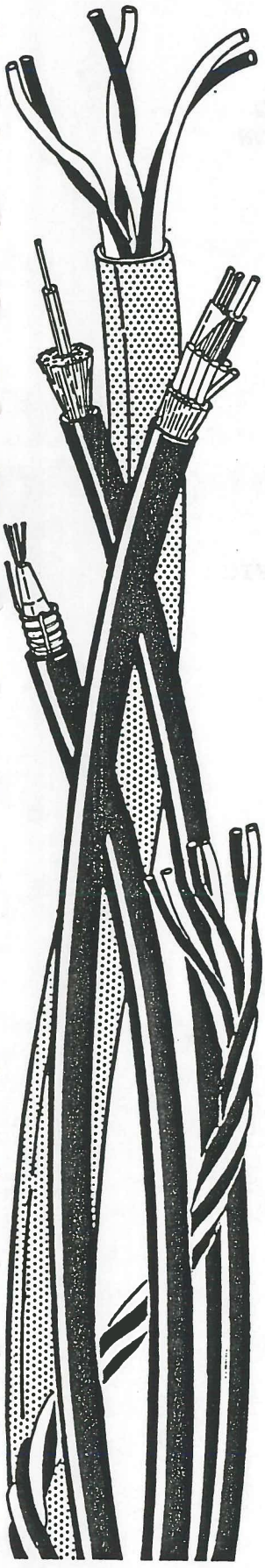
ADDRESS ADMINISTRATION (CONTINUED):

- APPLICATION PROGRAMS.

  - THE APPLICATION PROGRAM DOES NOT USUALLY NEED TO PUT THE RECEIVING ADAPTER'S ADDRESS IN THE MESSAGE, THIS IS HANDLED BY SUPPORT PROGRAMS SUCH AS THE NETWORK O/S.

  - ONE OR MORE ASSIGNED NAMES AND ADDRESSES IDENTIFY MOST APPLICATION PROGRAMS, SUPPORT PROGRAMS, AND OTHER INTERFACES FOR COMMUNICATIONS AND DATA EXCHANGE. A TABLE OR LIST IS USED TO CORRELATE A PROGRAM NAME WITH THE ADDRESS OF THE ADAPTER THE PROGRAM USES TO COMMUNICATE ON THE NETWORK. MANY OF THE PROGRAMS OR INTERFACES PROVIDE A FUNCTION OR FILE WITH WHICH TO ASSIGN THE REQUIRED NAMES TO CREATE THE LISTS OR TABLES. INTERFACES INCLUDE:

    NETBIOS
    IBM PC 3270 EMULATION PROGRAM
    OS/2 LAN SERVER
    APPC/PC
    ETC.



2. OTHER IDENTIFICATION:

° LOGIN IDs SHOULD BE MADE UP OF A USER'S FIRST INITIAL AND THE FIRST SIX LETTERS OF THEIR LAST NAME. CONSISTANCY IS THE KEY TO GOOD MANAGEMENT.

° PASSWORDS. THE NETWORK OPERATING SYSTEM WILL LET YOU PLACE CONTROLS OVER THE PASSWORDS AND ASSIST IN THEIR MAINTENANCE. USEFUL TIPS:

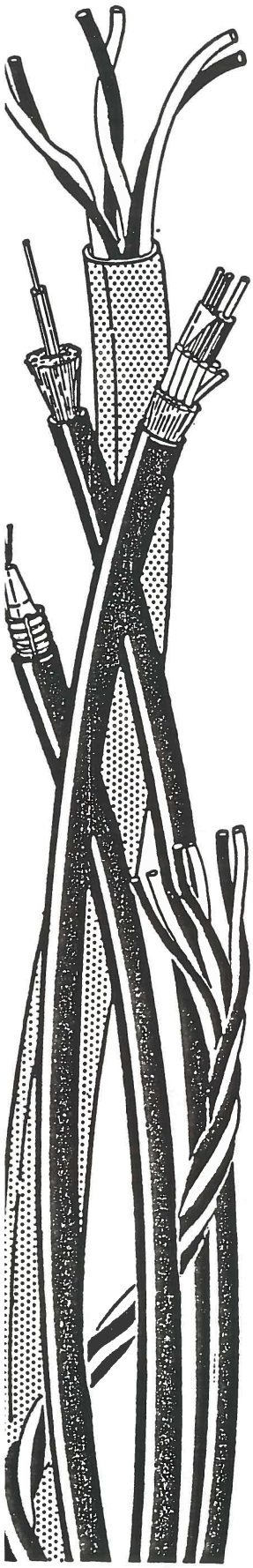
- NO INITIALS.
- NO PASSWORDS SHORTER THAN FOUR CHARACTERS.
- NO SIMPLE WORDS.
- NEVER SHARE PASSWORDS OR IDs.
- FORCE PASSWORD CHANGE AFTER 30 DAYS.
- LIMIT THE NUMBER OF TRIES FOR UNSUCCESSFUL LOGINS.

° GROUPS AND SERVERS SHOULD HAVE IDs/NAMES THAT ARE FAMILIAR BUT NOT WORDY.

- "TAX" FOR THE TAX DEPARTMENT'S SERVER.
- "ACCOUNTING" GROUP ADDRESS WILL HAVE A DIFFERENT SET OF WORK REQUIREMENTS THAN THE "SALES" GROUP.

° DIRECTORIES. DIRECTORY STRUCTURES SHOULD MEET THE NEEDS OF INDIVIDUAL USERS AND PROGRAMS, IF LAID OUT CORRECTLY SHOULD SIMPLIFY ADMINISTRATION.

- \USERID. EACH USER SHOULD HAVE A DIRECTORY FOR PERSONAL FILES AND CONFIGURATION PREFERENCES.
- \DOCUMENT\GROUPID. SHARED DOCUMENTS OR WORK FILES SHOULD BE GROUPED INT COMMON DIRECTORIES.
- \PROGRAMS\APPLID.VER. EACH GROUP SHOULD BE GIVEN ITS OWN DIRECTORY TO SIMPLIFY MAINTENANCE AND MINIMIZE NAMING CONFLICTS.
- \NETUTILS. FREQUENTLY USED UTILITIES SHOULD BE GROUPED INTO ONE DIRECTORY AND THEIR FUNCTIONS IDENTIFIED.
- \STATION\CPU\DOS.VER. EACH WORKSTATION TYPE SHOULD BE GIVEN ITS OWN DIRECTORY WHERE SPECIFIC WORKSTATION DRIVERS AND DOS VERSIONS ARE STORED.

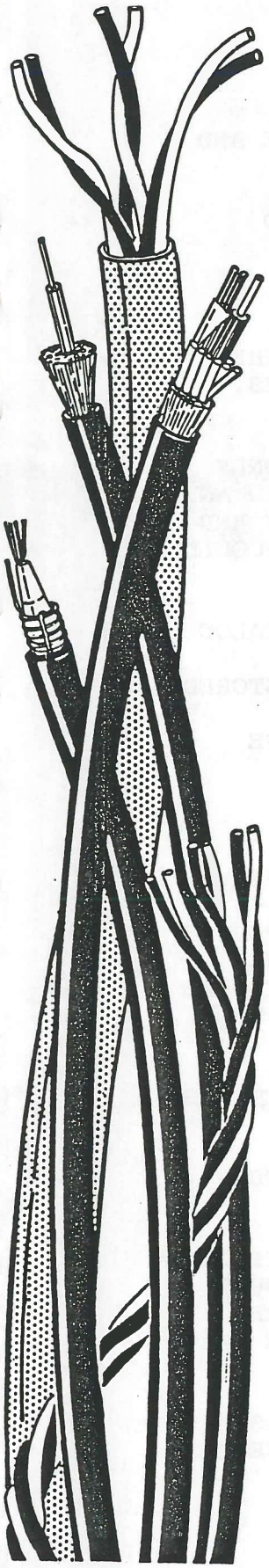


OTHER IDENTIFICATION (CONTINUED):

° DRIVE USAGE. DRIVE STANDARDS ASSIST WITH DEFINING MENUS AND LOCATING FILES. THE FOLLOWING ARE COMMON DEFAULTS:

A: - E:	LOCAL DISKETTE AND HARD DRIVES.
F:	NETWORK HOME DRIVE.
G: - L:	USER SPECIFIC DRIVE MAPPINGS.
M: - N:	SINGLE USER SOFTWARE, WHICH HAVE SOME UNIQUE SUPPORT REQUIREMENTS.
W:	\NETUTILS.
X:	\PROGRAMS APPID.VER.
Y:	PUBLIC. OR FOR THE NETWORK O/S SPECIFIC FILES SUCH AS FROM NOVELL OR BANYAN.

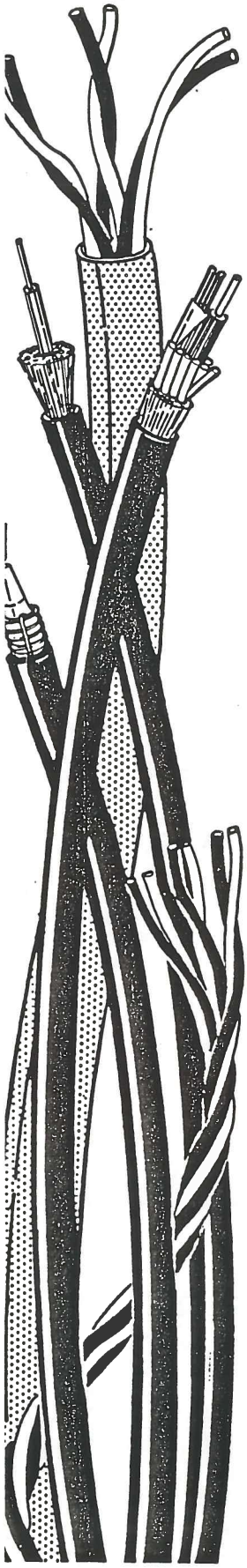
LAN MANAGER DUTIES



3. DISK MANAGEMENT:

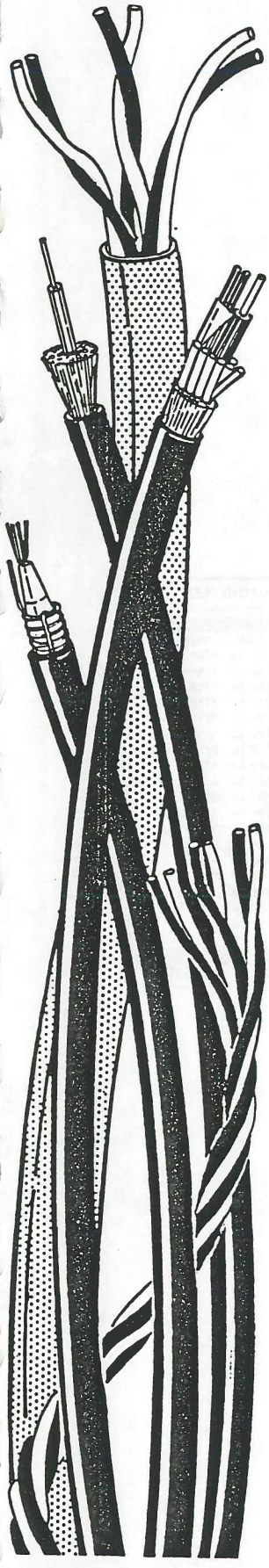
- KEEP THE SERVER DISK IN REASONABLE ORDER.
- BUILD AND MAINTAIN A LOGICAL AND ORGANIZED DIRECTORY STRUCTURE.
- TOO MANY SUBDIRECTORIES CAUSE SEARCH PROBLEMS.
- TOO FEW SUBDIRECTORIES MAKE FILES ELUSIVE.
- REGULAR USERS SHOULD BE PROHIBITED FROM MAKING NEW DIRECTORIES ON THE SERVER. WITH A GOOD MENU SYSTEM, USERS NEVER HAVE NEED OR OPPORTUNITY TO MAKE NEW DIRECTORIES.
- GET RID OF UNUSED FILES.
  - FILE USAGE PACKAGES CAN REPORT ON ACTIVITY OF FILES TO MAKE DELETE DECISIONS.
  - FILE USAGE PACKAGES ALSO CAN SHOW THE SIZE OF THE DISK SPACE CONSUMED BY A USER AND PRODUCE EXCEPTION REPORTS.
  - NETWORK O/S, SUCH AS NOVELL NETWARE, WILL LOG OFF GLUTTONOUS USERS.
- HEAVILY USED DISKS OVER TIME BECOME FRAGMENTED AND MUST BE REORGANIZED, AS DISK ACCESS PERFORMANCE WILL DECLINE.

LAN MANAGER DUTIES



4. DISK BACKUP:

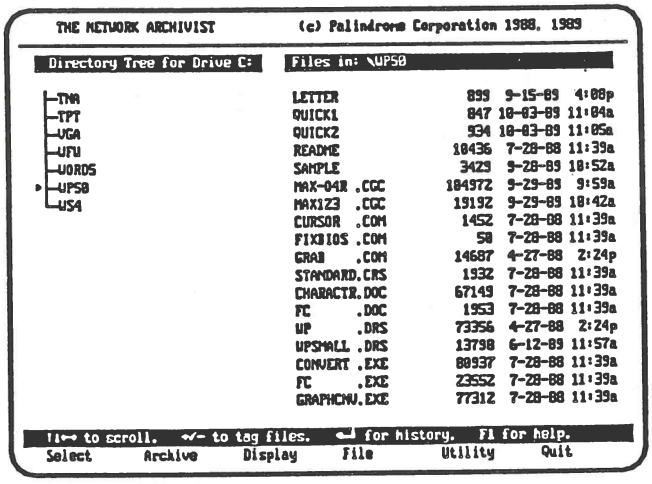
- TAPE BACKUP UNITS PROVIDE CONVENIENT, RELIABLE AND COST EFFECTIVE REMOTE STORAGE.
- ARCHIVE FILES THAT HAVEN'T BEEN USED LATELY TO SUPPORT GOOD DISK MANAGEMENT OBJECTIVES.
- BACKUP CAPABILITIES SUPPORT DISK REFORMATTING EASILY AS TAPE CAN BE RELOADED SO THAT FILES ARE RESTORED CONTIGUOUSLY: HOWEVER, THIS REQUIRES FILE-BY-FILE BACKUP NOT IMAGE BACKUP PROCEDURES, WHICH TAKES LONGER TO PERFORM.
- BACKUP SOFTWARE HAS TO TAKE INTO ACCOUNT NOT ONLY SIZE AND LOCATION OF DISK SERVER FILES BUT ALSO ANY HIDDEN INFORMATION ABOUT THEM SUCH AS SECURITY AND DIRECTORY RIGHTS OTHERWISE A ONE HOUR RESTORE COULD TAKE TEN HOURS.
- CONSIDER BACKUP SOFTWARE THAT KEEPS A TAPE CATALOG ON A HARD DISK TO SAVE TIME DURING RESTORE OR WHEN ONLY A SELECTIVE FEW FILES NEED TO BE RESTORED.
- THERE IS CURRENTLY LITTLE STANDARDS AMOUNG TAPE UNITS, A TAPE PRODUCED BY ONE UNIT MAY NOT BE READABLE BY ANOTHER TAPE UNIT.
- SEVERAL COMPANIES OFFER THE ABILITY TO BACKUP WORKSTATIONS' LOCAL HARD DISK AS WELL AS THE SERVER'S.
- DIGITAL AUDIO TAPE (DAT) CAN OFFER STORAGE CAPACITY INTO THE GIGABYTES AND IS MORE EFFICIENT IN THE STORAGE AND RESTORAL PROCESSES THAN THE TRADITIONAL QUARTER-INCH STREAMING TAPES, WHICH CAN GO UP TO 320 MEGABYTES.
- IMAGE BACKUP IS FASTER THAN FILE-BY-FILE PROCEDURES; HOWEVER, MULTITASKING O/S REDUCES THIS GAP. FILE-BY-FILE BACKUP ALSO SUPPORTS INCREMENTAL BACKUP - ONLY THOSE FILES THAT CHANGED SINCE THE LAST BACKUP NEED BE RESAVED.
- SUPPORT SOFTWARE SHOULD BE ABLE TO DEAL EFFECTIVELY WITH OPEN FILES DURING BACKUP. SOME PROGRAMS JUST SHIP THEM OVER WHILE OTHERS WAIT UNTIL THEY ARE CLOSED, WHICH SLOWS THE PROCESS. GET A PACKAGE THAT PROVIDES A LIST OF OPEN FILES ENCOUNTERED.
- A TAPE BACKUP SYSTEM THAT CAN RUN UNATTENDED IS A BETTER ONE BECAUSE BACKUPS GET DONE MORE FREQUENTLY.



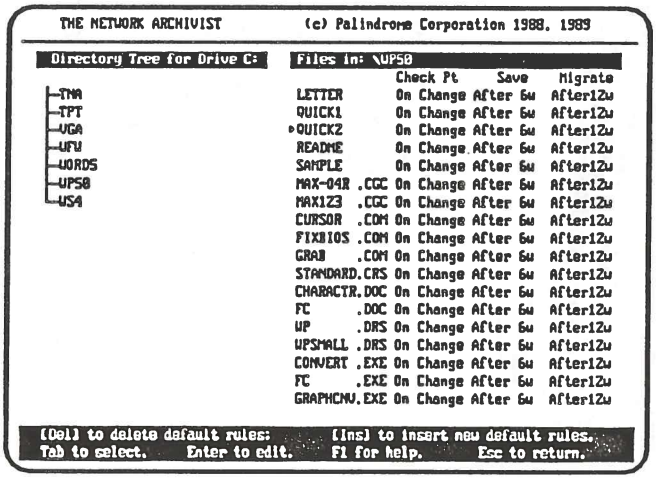
DISK BACKUP (CONTINUED)

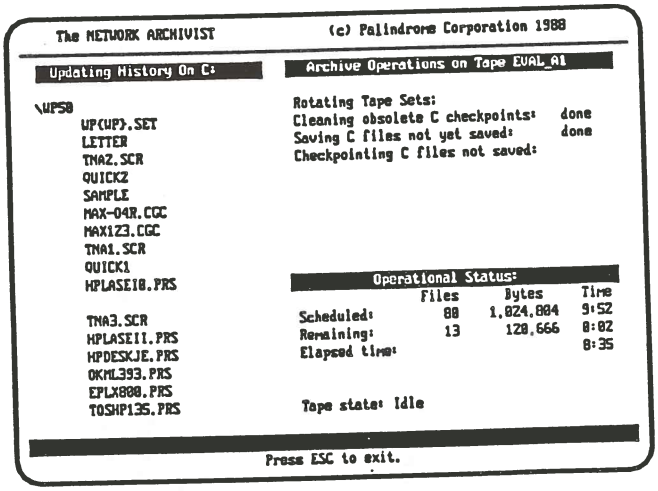
- EXTENDED LENGTH TAPE OR DATA COMPRESSION TECHNOLOGIES ARE ATTRACTIVE BUT NOT ALWAYS RELIABLE.
- EVEN THOUGHT THE SOFTWARE IS MENU DRIVEN, IT SHOULD ALSO SUPPORT THE WHOLE PROCESS FROM A COMMAND LINE.
- GENERATIONAL BACKUPS, WHERE WEEKLY TAPES ARE SAVED FOR A MONTH AND A MONTH TAPE SAVED FOR A YEAR, OR SOME SIMILAR PROCESS, ARE AN IMPORTANT MANAGEMENT PROCEDURE.
- STORE BACKUP TAPES IN AN AREA OTHER THAN WHERE THE SERVER IS LOCATED. MONTHLY AND YEARLY BACKUP TAPES SHOULD BE STORED EVEN FURTHER AWAY.
- DISK FAILURE IS LESS LIKELY A CAUSE TO RESTORE (MTBF RATES FOR HARD DRIVES ARE NOW UP TO 100,000 HOURS) THAN USERS UNWITTINGLY ERASING FILES OR, NOW A DAYS, VIRUS OR OTHER MALICIOUS ATTACKS.
- BACKUP SOFTWARE RARELY HAS SECURITY BUILT IN SO SENSITIVE DATA SHOULD ALSO BE ENCRYPTED OR THE BACKUP SHOULD BE PHYSICALLY SECURED, PERHAPS OFF-SITE.

SERVER DISK BACKUP SYSTEMS

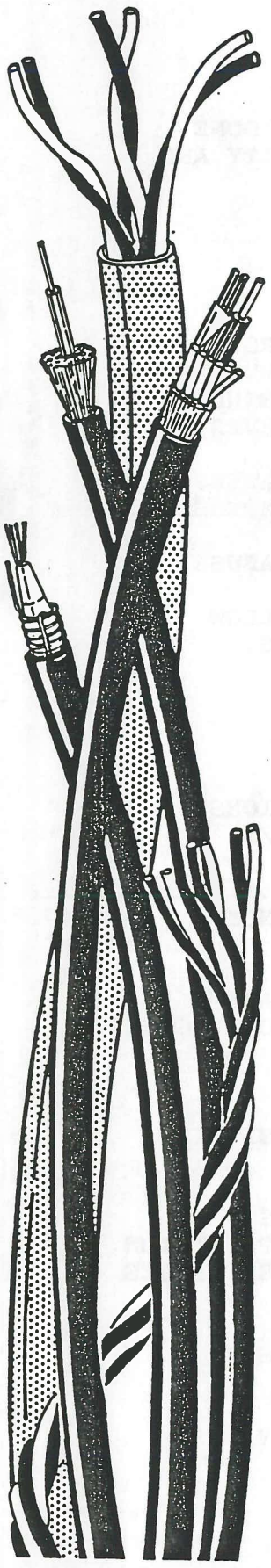


MENU DRIVEN SYSTEMS
PROVIDE VARIOUS STATUS
AND MONITORING SCREENS
DURING BACKUP PROCESS





LAN MANAGER DUTIES



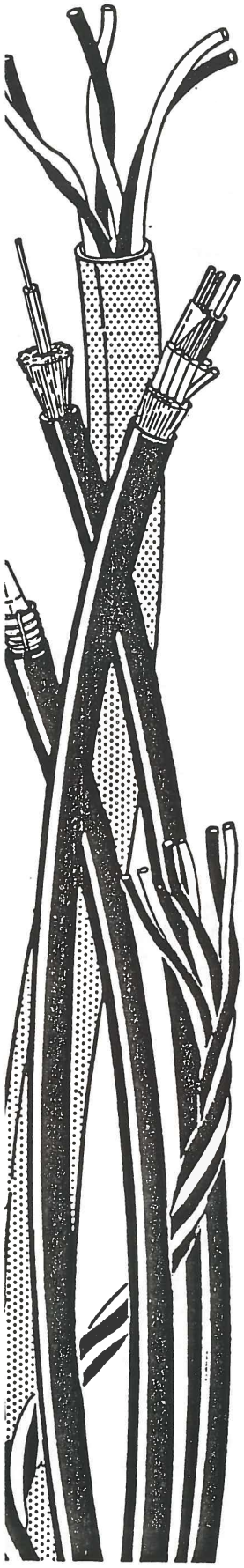
5. FRONT-END PROGRAMS

- PROVIDING AN EASY TO USE INTERFACE TO THE NETWORK FOR THE END USER IS ONE OF THE BIGGEST JOBS OF THE LAN MANAGER.
- THE DUTIES OF THE FRONT-END IS TO SIMPLIFY THE WHOLE PROCESS OF WORKING ON A LAN FROM LOGGING-IN TO RUNNING APPLICATIONS, FROM CHANGING DIRECTORIES TO PRINTING FILES.
- FRONT-ENDS ISOLATE THE NETWORK FROM THE USER AND VISA VERSA.
- LAN MANAGERS CAN SET UP DOS BATCH FILES WHICH AUTOMATICALLY DO THINGS LIKE LOADING NETWORK SOFTWARE, LOGGING IN USERS, SET UP DRIVE LETTER MAPPINGS AND SEARCH DRIVES.
- NETWARE BY NOVELL HANDLES LOG-IN TASKS WITH LOG-IN SCRIPTS.
- LAN MANAGERS MUST WRITE AND MAINTAIN BATCH FILES AND SCRIPTS.
- PRINTING FROM AN APPLICATION, LIKE LOTUS 123 OFTEN REQUIRES THAT A SPOOL COMMAND BE ISSUED BEFORE THE APPLICATION IS ENTERED, WHICH CAN ALSO BE ACCOMPLISHED BY BAT FILE, SUCH AS 123.BAT.
- BAT FILES CAN ALSO DYNAMICALLY MAP AN APPLICATION'S DIRECTORY AND A USER'S DIRECTORY TO DRIVE LETTERS AS IT MIGHT NOT BE POSSIBLE TO MAP EVERY APPLICATION TO IT OWN DRIVE LETTER IN LOGIN SCRIPTS. EXAMPLE OF A BATCH FILE THAT DOES THIS:

```
MAP F: =  LOTUS                 (PROGRAM DIRECTORY)
MAP H: =  123 DAT\GARY          (USER'S DATA)
F:                              (SWITCH TO PROGRAM DRIVE)
SPOOL                           (REDIRECT OUTPUT TO
                                 NETWORK PRINTER)
123                             (RUN 123)
ENDSPOOL                        (SUBMIT PRINT JOBS
                                 TO NETWORK PRINTER)
```

- SOME NETWORK O/S AND THIRD PARTY VENDORS PROVIDE A MENU UTILITY WHICH ALLOWS A LAN MANAGER TO EASILY AND QUICKLY CONSTRUCT A MENU DRIVEN INTERFACE BETWEEN THE END USER AND THE NETWORK COMMANDS.

LAN MANAGER DUTIES



6. SECURITY:

° THERE SHOULD BE RULES FOR THE WAY THINGS ARE DONE ON A LAN, WHICH IS ESPECIALLY TRUE FOR SECURITY AND DISASTER RECOVERY REASONS.

° ACCESS CONTROL - PASSWORDS.

- DON'T SHARE THEM.
- CHANGE TEM OFTEN.
- NO COMMON WORDS OR LESS THAN FIVE CHARACTERS.
- PASSWORD GENERATORS ARE CREDIT-CARD SIZE DEVICES WHICH GENERATE NEW PASSWORDS EVERY THIRTY MINUTES WHICH IS ALSO DONE SIMULTANEOULY IN THE SERVER.
- BIOMETRIC TECHNIQUES, LIKE FINGER PRINT READERS ADD AN EXTRA LEVEL OF PROTECTION BUT ARE EXPENSIVE.
- ENCRYPTED PASSWORDS PREVENT SOME PASSWORD ABUSE.
- SOME THIRD PARTY SOFTWARE OR NETWORK O/S ALLOW TIME-OF-DAY ONLY ACCESS TO SYSTEM AND FILES.

° ACCESS CONTROL - FILE AND DIRECTORY LEVEL.

- LIMIT ACCESS TO CERTAIN DIRECTORIES, FILES, AND PROGRAMS OR LIMIT FUNCTION THAT CAN BE PERFORMED ON A FILE BY A USER ARE RESTRICTIONS THAT ARE USUALLY PROVIDED BY THE NETWORK O/S.
- PROPRIETARY OPERATING SYSTEMS, LIKE THOSE USED BY NOVELL, RESTRCIT ACCESS FROM DOS ONLY OR OTHER COMMON MACHINES.
- SOME THIRD PARTY SOFTWARE AND ADD-ON HARDWARE AVAILABLE THAT ALSO RESTRICTS FILE/DIRTECTORY ACCESS.

° AUDIT TRAILS.

- DETECTS BREACHES AND IDENTIFIES WHO IS COMMITTING THEM.
- RECORDS WHAT IS GOING ON IN SYSTEM - WHO IS LOGGING-IN AND OUT, WHO IS RUNNING WHAT APPLICATION OR USING WHAT RESOURCE, WHO IS DELETING WHAT FILES AND WHEN, ETC.
- THIRD PARTY SOFTWARE AVALIABLE PLUS THIS IS A STRONG FEATURE OF SOME NETWORK O/S.
- ONE PROBLEM IS SPENDING THE TIME ON A DAILY BASIS TO LOOK OVER ALL ACTIVITY LISTED.

LAN MANAGER DUTIES

SECURITY (CONTINUED)

° ENCRYPTION.

- ENCRYPT ALL INFORMATION ON THE NETWORK IS THE BEST PROTECTION AS ANYONE WITH A NETWORK/PROTOCOL ANALYZER CAN GET AT AND READ DATA AND PASSWORDS.

- EXPENSIVE TO ENCRYPT ALL OF THE INFORMATION, AND POSSIBLY IMPACT PERFORMANCE, SO ENCRYPT PASSWORDS AND SENSITIVE DATA ONLY.

° PHYSICAL SECURITY.

- TAPPING A COPPER, UTP (UNSHIELDED TWISTED PAIR) LAN CABLE IS VERY EASY AND NEED NOT REQUIRE BREAKING OR CUTTING INTO THE CABLE, MERELY SENSING THE ELECTROMAGNETIC RADIATION NEAR THE CABLE IS ENOUGH.

- FIBER CAN ALSO BE NON-INTRUSIVELY TAPPED BY CUTTING BACK THE CLADDING AND SENSING THE PHOTON ENERGY THROUGH THE CORE.

- LANS CAN ALSO BE QUICKLY SABOTAGED BY SLIDING A COMMON PIN INTO THE CABLE, WHICH SHORTS OUT THE SIGNAL, AND IS HARD TO DETECT.

- RF (RADIO FREQUENCIES BROADCASTED) SIGNALS FROM MONITORS AND COMPUTERS CAN BE SENSED OVER LONG DISTANCES. GOVERNMENT TEMPEST CERTFIED HARDWARE MINIMIZES THIS THREAT.

- INTERCONNECTION WITH OTHER NETWORK OR ALLOWING ANY PROGRAM TO RUN ON A NETWORK WORKSTATION OPENS THE DOOR TO NETWORK VIRUSES.

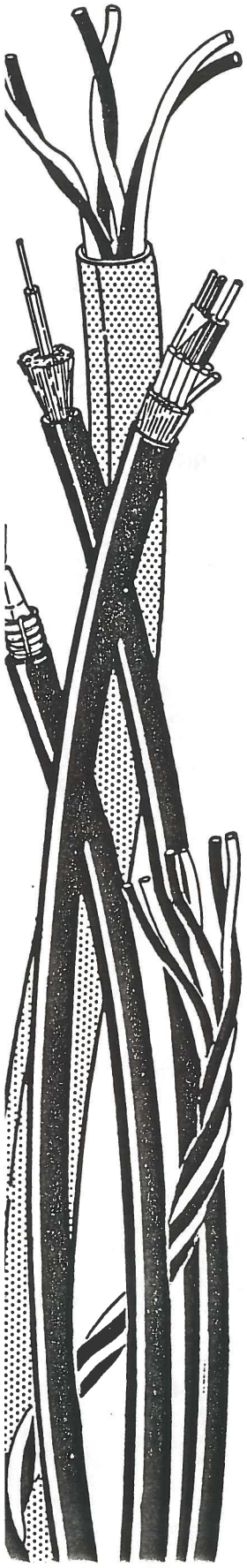
- SCREEN ALL NEW SOFTWARE OFFLINE AND DISCOURAGE THE USE OF PERSONAL PROGRAMS ON THE SYSTEM.

- DELETE UNAUTHORIZED PROGRAMS, PERIODICALLY SWEEP THE NETWORK DELETING EXE AND COM FILES THAT ARE NOT IN APPROVED AREAS. SWEEP WORKSTATION HARD DRIVES DAILY OR AT LOG-IN.

- RESTRICT OUTSIDE (OFF LAN) ACCESS BY USING COMMUNICATION SERVERS, WHICH PROVIDE A MEASURE OF CONTROL AS TO WHAT IS BEING ACCESSED. ACCESS ONLY LIGITIMATE SOURCES, NO BULLETIN BOARDS, AND USE AUDIT TRAILS.

- GRANT PRIVALEDGES SELECTIVELY IF NEED MULTIPLE LAN ADMINISTRATORS/MANAGERS, WHO CAN DO THE MOST DAMAGE.

LAN MANAGER DUTIES



SECURITY (CONTINUED AGAIN)

- ANY DIAL ACCESS INTO THE SYSTEM SHOULD USE "DIAL-BACK" DEVICES, WHICH ALLOWS THE CALLER TO LEAVE A CODE WITH THE DEVICE AND THE DEVICE LATER MAKES A CALL OUT TO THAT INDIVIDUAL'S MACHINE USING A PREDETERMINED TELEPHONE NUMBER.

- USE AUTO-DISCONNECT DEVICES TO PREVENT SOMEONE FROM BEING CONNECTED TO AN INPUT PORT WHOSE PREVIOS CALLER'S LINE FAILED. THE SECOND CALLER MAY GET CONNECTED TO THE FIRST CALLER'S SESSION.

- THIRD PARTY PRODUCTS PROVIDE SECURE GATEWAYS AND BRIDGES THAT PROTECT THE NETWORK FROM OUTSIDE UNAUTHORIZED ACCESS, ESPECIALLY WHEN MULTIPLE LANS ARE INTERCONNECTED AND/OR CONNECT THROUGH A MAINFRAME, SOME NETWORKS HAVE GROWN TO OVER 30,000 USERS ON A SINGLE LAN.

- DISKLESS WORKSTATIONS ARE MORE SECURE THAN ONES THAT MUST BE BOOTED LOCALLY.

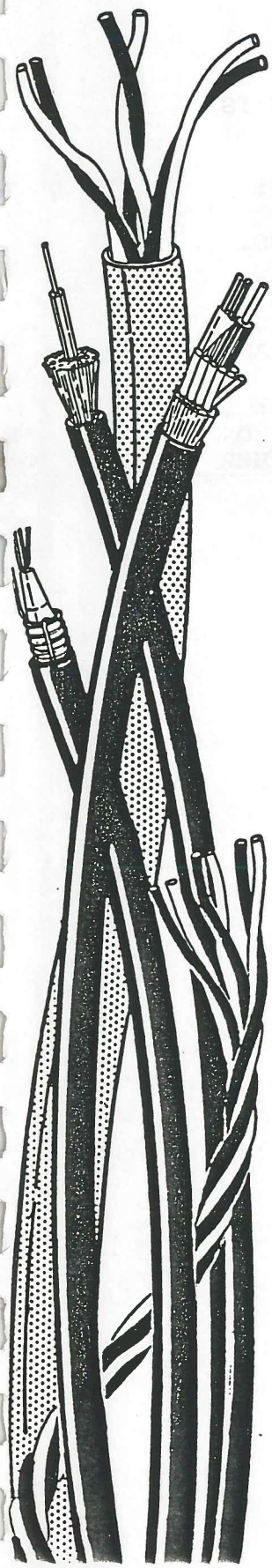
- BE AWARE OF WHO IS PLACING A NETWORK/PROTOCOL ANALYZER ON THE NETWORK AS THESE DEVICES CAN SEE AND RECORD ALL INFORMATION TRAVERSING THE NETWORK. SOME CAN BE SET UP TO NOT INTERFERE WITH THE NORMAL TRAFFIC FLOW OR CONDITIONS OF THE LAN, WHICH IS GOOD FOR LEGITIMATE TESTING BUT CAN ALSO HIDE UNAUTHORIZED CONNECTIONS.

- FOR ADDED SECURITY, REMOVE AND LOCK UP ALL DRIVES AT NIGHT. WITHOUT BACKUP, A SIMPLE HARDWARE BURGLARY CAN BECOME A DISASTER.

- LOCK UP OTHER IMPORTANT HARDWARE. A FULLY MIRRORED SERVER DISK CAN BE REMOVED WITHOUT ANYONE LEARNING ABOUT IT FOR DAYS AS LONG AS THE PRIMARY DISK KEEPS RUNNING.

- BACKUP TAPES SHOULD ALSO BE KEPT IN A SECURE LOCATION AS BACKUP SYSTEMS OFTEN DO NOT ENCRYPT THE DATA.

LAN MANAGER DUTIES



7. PERFORMANCE MONITORING:

- KNOW WHICH FILES ARE BEING HEAVILIY UTILIZED IN ORDER TO PROPERLY RECONFIGURE THE SYSTEM AND BALANCE THE LOAD OVER MORE SERVERS OR MULTIPLE DISK ON ONE SERVER SYSTEM.

- THROUGHPUT AND RESPONSE TIME CAN DEGRADE IF THE SERVER IS BACKLOGGED WITH REQUESTS FOR THE SAME DISK, FILE, APPLICATIONS, ETC.

- HARDWARE MONITORS AND SOFTWARE TRACE PROGRAMS CAN PROVIDE TRAFFIC LEVELS AND USAGE INFORMATION. THIS INFORMATION IS INVALUABLE FOR TROUBLESHOOTING PROBLEMS WITH THE NETWORK, BRIDGE/ROUTERS OR GATEWAYS AND FOR NETWORK REDESIGN. THE "CHERNOBYL" EFFECT ON LANS IS A REAL PHENOMENON.

- PERFORM PERIODIC THROUGHPUT TESTS BY BENCHMARKING MULTIPLE FILE TRANSFERS OR PROGRAM ACCESSES IN ORDER TO UNDERSTAND GROWTH CHOKE POINTS AHEAD OF TIME. THIRD PARTY TEST-BED PROGRAMS ALSO PRODUCE A NUMERIC INDEX OF THE SYSTEMS PERFORMANCE EACH TIME TESTS ARE RUN.

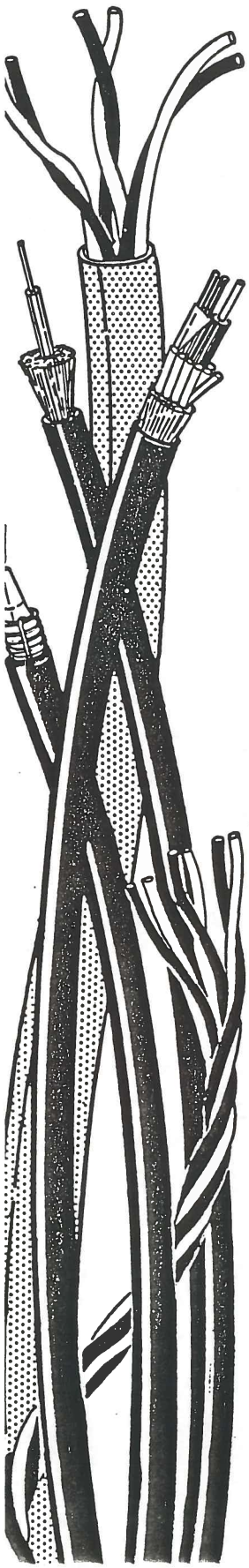
- SOFTWARE LICENSE MONITORING, WHICH IS OFTEN PART OF AN AUDIT TRAIL PACKAGE, PROVIDE A METERING METHOD BY WHICH USERS "CHECK OUT" PROGRAMS LIKE A LIBRARY.

- BILLING FOR NETWORK AND RESOURCE USAGE WILL BECOME MORE COMMON AND IMPORTANT AS THE COST OF PROVIDING SHARED SERVICES, INCLUDING NETWORK ADMINISTRATION, GROWS. THIS IS ESPECIALLY TRUE WITH LARGE, INTERCONNECTED, MULTIDEPARTMENT, MULTIDIVISIONAL SYSTEMS. AUDIT TRAIL PACKAGES CAN BE USED AS WELL AS ADVANCED FEATURES OF THE NETWORK O/S.

- THE NUMBER OF USERS LOGGED ON TO THE NETWORK AT VARIOUS TIMES OF THE DAY AS WELL AS THE SIZE OF THE PRINT QUEUES ARE ALSO IMPORTANT STATISTICS REQUIRED FOR SOUND NETWORK MANAGEMENT.

- LARGE INTERCONNECTED LAN SYSTEMS WITH MANY BRIDGES, ROUTERS, SERVERS AND GATEWAYS CAN BE CENTRALLY MANAGED WITH THE HELP OF PACKAGES THAT PROVIDE USAGE AND DIAGNOSTIC INFORMATION ABOUT REMOTE DEVICES. NETWORK O/S AS WELL AS THIRD PARTY PACKAGES INCONJUNCTION WITH HARDWARE FEATURES ARE BEING DEVELOPED AROUND THE SIMPLE NETWORK MANAGEMENT PROTOCOL (SNMP) DEFACTO STANDARD.

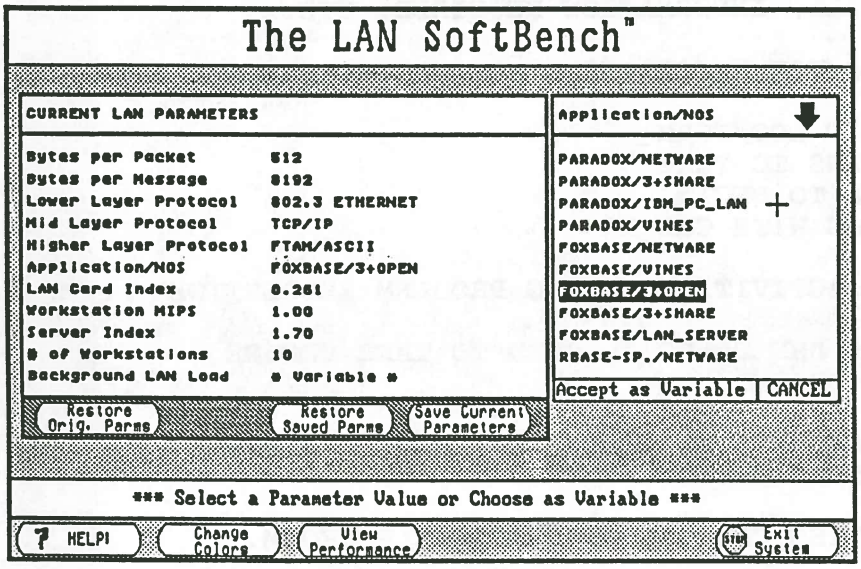
LAN MANAGER DUTIES



8. END USER HELP:

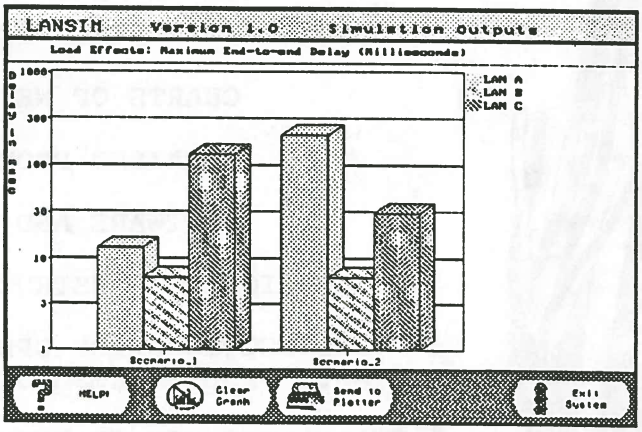
- A LARGE PART OF THE LAN MANAGER'S JOB AND TIME IS INVOLVED IN RUNNING FROM DESK TO DESK.
- SOME NETWORK O/S HELP UTILITIES IMPROVE THINGS; HOWEVER, THERE STILL SHOULD BE A SINGLE NUMBER TO CALL FOR ASSISTANCE AS USERS ARE NOT TECHIES.
- REMOTE PC HELP PRODUCTS LIKE "CARBON COPY" ARE NOW AVAILABLE FOR LANS. THESE ALLOW A LAN MANAGER TO CONNECT TO A REMOTE WORKSTATION'S KEYBOARD AND MONITOR AS IF SITTING IN FRONT OF IT. THE LAN MANAGER CAN INPUT COMMANDS AS IF THEY CAME FROM THE WORKSTATION AND SEE THE RESULTS AS DISPLAYED ON THE REMOTE WORKSTATION WITHOUT LEAVING HIS/HER LAN MANAGER'S DESK.

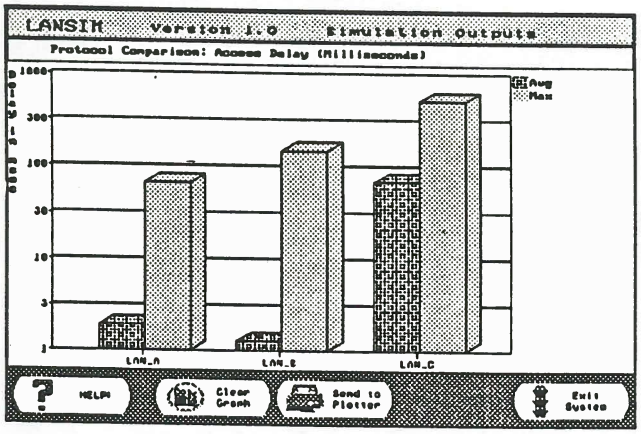
LAN BENCH MARK TESTING PACKAGES



PARAMETER SET UP SCREEN SHOWS TYPE OF TEST BED TO RUN

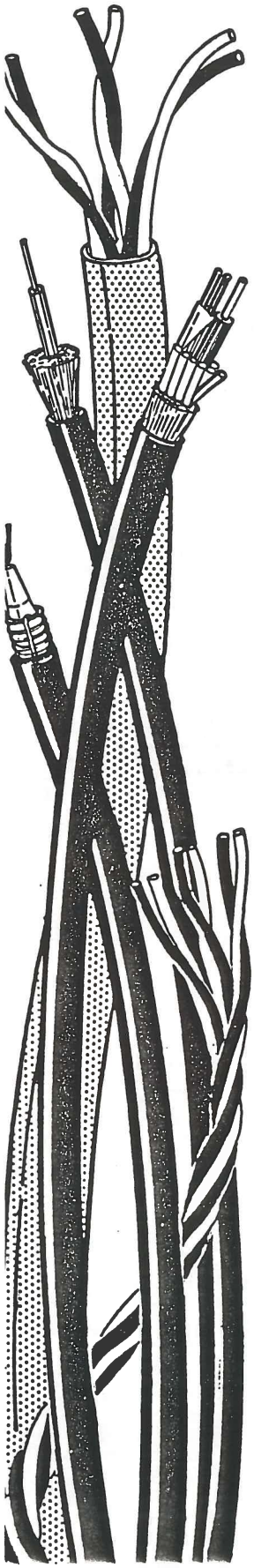
RESULTS: LOAD EFFECTS - MAXIMUM END-TO-END DELAY (MILLISECONDS)





PROTOCOL COMPARISON: ACCESS DELAY (MILLISECONDS)

LAN MANAGER DUTIES



9. TROUBLESHOOTING:

° ESTABLISH PROBLEM REPORTING AND RESOLUTION PROCEDURES:

- INSTRUCTIONS FOR REPORTING A NETWORK PROBLEM; NUMBER TO CALL, INFORMATION REQUIRED, ETC.

- INSTRUCTIONS FOR RECORDING REPORTED PROBLEMS.

  REPORT LOG/FORM
  ACTIONS TO TAKE
  WHERE TO BEGIN
  DIALOG WITH CALLER

° ASSIGNMENT OF ACTIVITIES DURING PROBLEM RESOLUTION

- WHAT ACTIONS ARE USERS ALLOWED TO TAKE BEFORE REPORTING PROBLEM.

- WHO IS RESPONSIBLE FOR CERTAIN ACTIVITIES AFTER A PROBLEM IS REPORTED.

- WHAT ACTIVITIES CAN THE LAN MANAGER PERFORM.

° ITEMS AND INFORMATION REQUIRED FOR PROBLEM RESOLUTION.

- LIST OF MATERIALS NEEDED:

  CHARTS OF NETWORK ORGANIZATION AND LAYOUT.

  DETAILED PROBLEM DETERMINATION PROCEDURES.

  SOFTWARE AND HARDWARE DOCUMENTATION.

- LOCATION AND INSTRUCTIONS FOR OBTAINING MATERIALS.

- INSTRUCTIONS FOR UPDATING CHARTS AND DOCUMENTATION WHEN PROBLEM RESOLUTION RESULTS IN A NETWORK CHANGE.

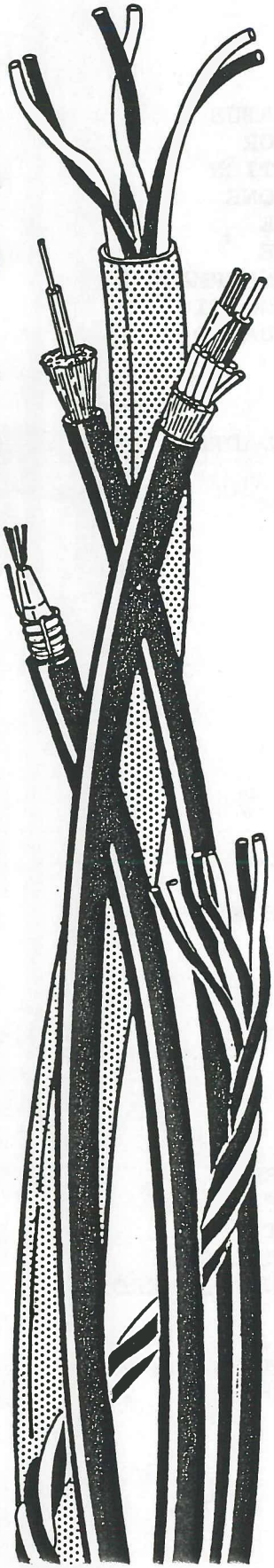
° GUIDELINES FOR CHANGING NETWORK COMPONENTS.

- OFF SHIFT ONLY

- NOTIFY END USERS OF OUTAGE POTENTIAL.

- DECISION BASED UPON RISK, HARDWARE TYPE, BEFORE BACKUP PERFORMED, ETC.

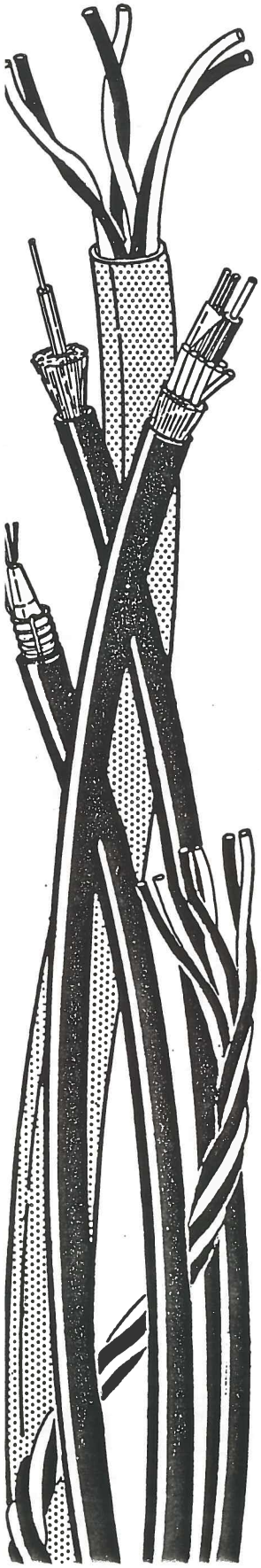
LAN MANAGER DUTIES



TROUBLESHOOTING (CONTINUED)

- INSTRUCTIONS FOR OBTAINING OUTSIDE SERVICES:
  - ESCALATION PROCEDURE.
  - SYSTEM TECHNICIAN NAMES/NUMBERS
  - VENDOR/SUPPLIER NAMES/NUMBERS
  - MAINTENANCE/SERVICE CONTRACTORS NAME/NUMBER
  - PAPER WORK REQUIRED.
  - INSTRUCTIONS FOR OBTAINING/RETURNING SOFTWARE OR HARDWARE PRODUCTS.
- INSTRUCTIONS FOR MAINTAINING PROBLEM RECORDS AND PRODUCING MONTHLY STATUS REPORTS.

DIAGNOSTIC TOOLS



1. LAN ADAPTER DIAGNOSTICS:

LAN ADAPTERS ARE DESIGNED TO OBTAIN CERTAIN STATUS AND ERROR INFORMATION ABOUT ATTACHING DEVICES OR LAN SEGMENT. THE ADAPTERS PROVIDE THIS INFORMATION TO CERTAIN PROGRAMS THAT REQUEST IT. AT LEAST ONE PROGRAM THAT GATHERS THIS INFORMATION SHOULD BE AVAILABLE AT ALL TIMES ON EACH LANSEGMENT. SOME DEVICES, SUCH AS BRIDGES AND ROUTERS PROVIDE INFORMATION TO CENTRALIZED NETWORK OR MAINFRAME BASED DIAGNOSTIC TOOLS SUCH AS IBM's LAN MANAGER OR IBM'S HOST BASED NETVIEW.

ADAPTER DIAGNOSTIC TESTS SHOULD BE RUN AFTER INSTALLATION, AFTER REPAIR OR REPLACEMENT OF ADAPTER, OR TO VERIFY SUSPECTED ADAPTER PROBLEMS.

2. NETWORK MANAGEMENT PROGRAM/UTILITIES:

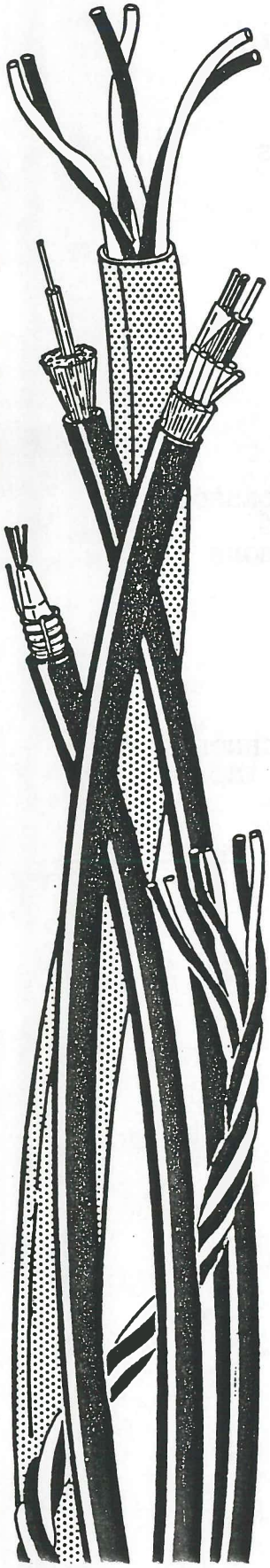
PROPRIETARY NETWORK O/S SOFTWARE OFTEN PROVIDES SOME LEVEL OF NETWORK DIAGNOSTIC INFORMATION. THIRD PARTY PACKAGES BASED UPON PROPRIETARY SCHEMES OR SNMP ARE ALSO AVAILABLE; HOWEVER, THIS AREA OF CAPABILITY TRADITIONALLY LAGS BEHIND OTHER FEATURES AND CAPABILITIES IN NETWORKING.

3. NETWORK DOCUMENTATION PACKAGES:

NETWORK CONFIGURATION AND DOCUMENTATION PACKAGES ARE AVAILABLE THAT FACILITATES KEEPING TRACK OF HARDWARE INVENTORY AND LOCATION, NETWORK LAYOUT, PHYSICAL WIRE LAYOUT AND RUNS, CIRCUIT IDs, HARDWARE AND WIRE SPARES, CONDUIT/BACKBONE LINKS, MDF AND IDF CROSS CONNECT CONFIGURATIONS, ETC.

SOME ADVANCED PACKAGES PRODUCE WORKSTATION DOCUMENTATION, TROUBLE REPORT LOGS, WORK ORDERS, AND OTHER SUPPORT PAPER.

DIAGNOSTIC TOOLS



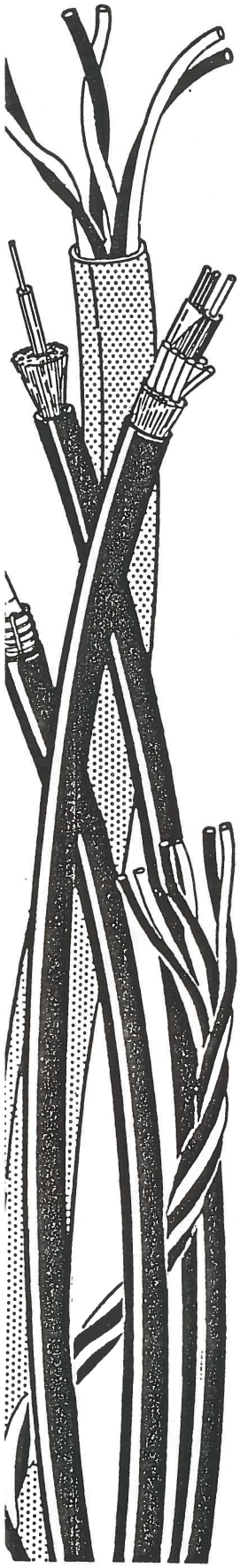
4. CABLE TESTERS:

- TONE GENERATORS AND DETECTORS ARE USED TO TRACE CABLE, USUALLY TWISTED PAIR, BETWEEN CROSS CONNECTS.
- CABLE CONTINUITY TESTERS PROVIDE A "GO/NO GO" TEST FOR CABLE SHORTS OR OPENS.
- TIME DOMAIN REFLECTOMETER (TDR) IS USED TO DETECT FAULTS OR OTHER BAD CONDITIONS IN THE CABLE. BY SENDING A RADAR-LIKE SIGNAL INTO ONE END OF THE SUSPECTED CABLE, FAULTS CAN BE IDENTIFIED TO WITHIN INCHES OF THE PROBLEM. THESE ARE AVAILABLE FOR COPPER OR FIBER BASED CABLES.
- POWER LINE TESTERS MEASURE AND MONITOR POWER COMING INTO THE WORKSTATIONS/SERVERS/BRIDGES OR OTHER CRITICAL EQUIPMENT FOR POWER SPIKES, DROPS, NOISE OR OUTAGES. SOME COME WITH RECORDING OR PRINTING CAPABILITY FOR RECORD KEEPING AND LOGGING. NOTE: TOO MANY DEVICES THAT USE POWER SUPPLIES, SUCH AS WORKSTATIONS, BEING PLUGGED INTO THE SAME POWER CIRCUIT CAN CAUSE WALL FIRES EVEN IF THE TOTAL LOAD IS LESS THAN THE POWER CIRCUIT'S CAPACITY DUE TO THE MANNER IN WHICH POWER SUPPLIES USE THE ELECTRICITY.

5. VOLT/OHM METERS (VOM):

- MEASURE THE RESISTANCE OF CABLE TERMINATIONS AND CABLE TERMINATOR.
- OHM METER CAN ALSO BE USED AS A CONTINUITY CHECKER FOR TESTING OPENS AND SHORTS IN CABLES.
- VOLT METER CAN BE USED TO TEST LAN CABLE VOLTAGE LEVELS, OUTPUT FROM EQUIPMENT POWER SUPPLIES, AND TO TEST THE LEVELS ON CRITICAL LEADS OF COMMUNICATIONS INTERFACES SUCH AS RS-232 OR AUI CABLES.

DIAGNOSTIC TOOLS



6. BREAK OUT BOX (BOB):

- TEST, CHECK, RECONFIGURE AND MEASURE THE SIGNALS GOING OVER AN RS-232 INTERFACE. A MUST IN ANY DATA COMMUNICATIONS TROUBLESHOOTING TOOL KIT.
- SMART BOB PROVIDES EASY TO USE TESTS AND CHECKS WITHOUT ALL OF THE EFFORT OF A MANUAL BOB.

7. WALKI TALKIES:

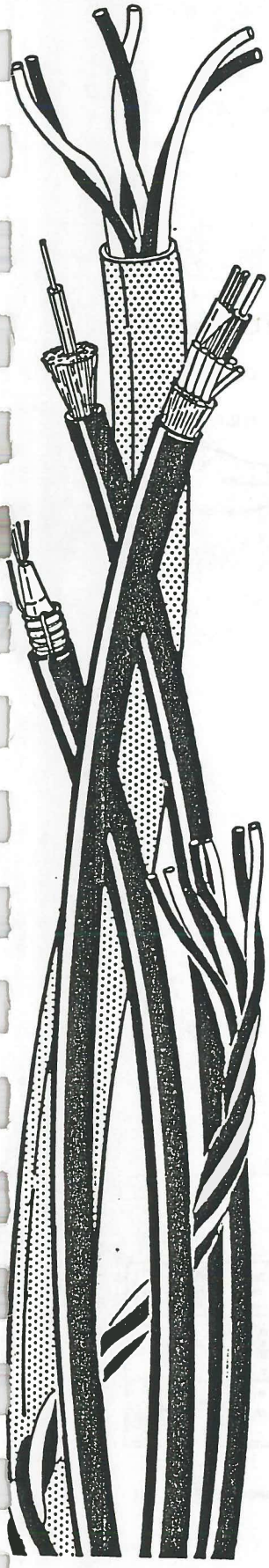
- ESPECIALLY USEFUL WHEN TRACING CABLES OR TROUBLESHOOTING LINE PROBLEMS, INSIDE OR OUTSIDE. COMMUNICATING AMONG AREAS WITHOUT TELEPHONES OR DURING TELEPHONE SYSTEM OUTAGES.

8. PC DIAGNOSTIC SOFTWARE:

- PACKAGES SUCH AS PC-TECHNICIAN FROM WINDSOR TECHNOLOGIES, INC. SAN RAFAEL, CA OR SYSTEM SLEUTH FROM DTG, INC. EL TORO, CA PROVIDE ADVANCED PC TESTING, WHICH IN A PC LAN SYSTEM CAN BE EXTREMELY HELPFUL.

9. SPECIAL TOOLS:

- ETHERNET LINE MONITOR
- ARCNET NETWORK TESTER



10. NETWORK ANALYZER/PROTOCOL ANALYZER

- A KEY PART OF ANY MANAGER'S TOOL BOX BECAUSE THEY SHOW ANY AND ALMOST ALL ACTIVITY ON THE NETWORK AND DISPLAY THE INFORMATION IN EASY TO USE TABLES, CHARTS, AND GRAPHS.

- BECAUSE THEY CAN SHOW WHICH NODE IS SENDING OUT TRAFFIC THEY CAN ISOLATE A NODE THAT IS STUCK TRANSMITTING (CALLED STREAMING) OR ONE THAT CAN'T TRANSMIT AT ALL.

- THEY CAN BE USED AS A MONITOR AND CHANGE THE MANAGEMENT TASK FROM REACTIVE TO PROACTIVE. BY SOUNDING ALARMS THAT WARN WHEN CERTAIN DANGEROUS CONDITIONS ARE ABOUT TO OCCUR, THE MANAGER HAS A CHANCE TO AVERT DISASTER.

- THEY ARE SOLD BY TYPE, ETHERNET AND TOKEN PASSING BEING THE MOST POPULAR AND COME IN DESK TOP, PORTABLE, AND FIELD VARIETIES.

- MOST USE A FLITERING TECHNIQUE TO TRAP THE SELECTED INFORMATION NEEDED TO RESOLVE A PROBLEM RATHER THAN ATTEMPT TO KEEP ALL THE INFORMATION THAT IT SEES. IT IS MOSTLY USED IN PASSIVE MODE WHICH DOES NOT INTERFERE WITH THE DATA GOING BY, ONLY COPYING SOME OF IT. IN AN ACTIVE MODE NETWORK ANALYZERS CAN PERFORM TESTS BY SENDING OUT PACKETS AND MONITORING THE RESPONSES.

- TYPICAL STATISTICS PROVIDED BY THESE MONITORS INCLUDE:

  - TOTAL STATIONS ON THE NETWORK, TOTAL ACTIVE STATIONS.

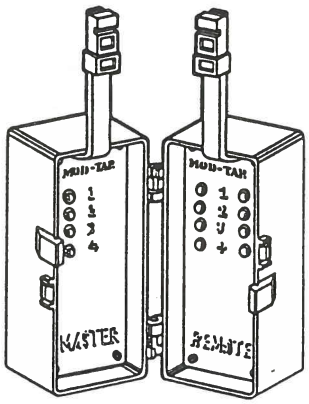
  - CURRENT AND AVERAGE NETWORK USAGE; TOTAL AND CURRENT BYTES, AND TOTAL AND AVERAGE FRAME SIZES.

  - ERROR STATISTICS SUCH AS NUMBER OF CRC AND ALIGNMENT ERRORS AND THE NUMBER OF UNSAVED FRAMES.

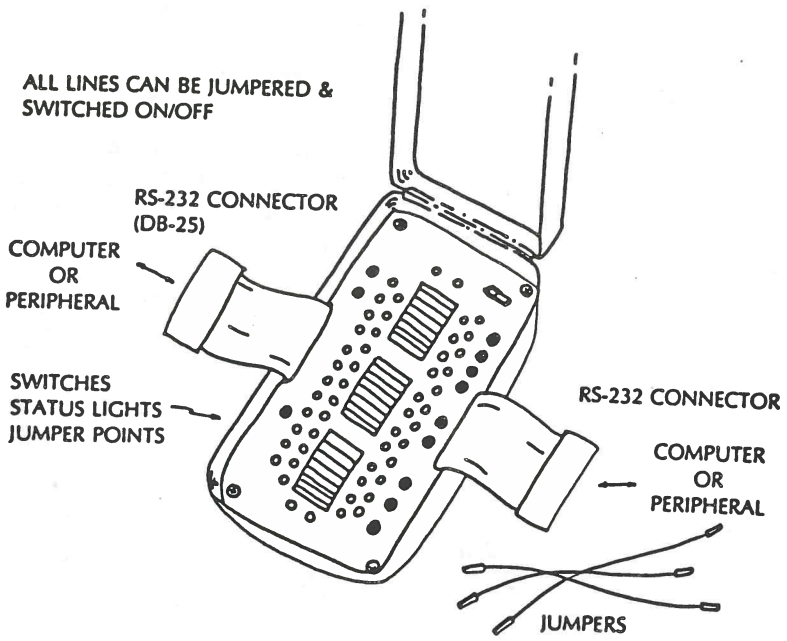
  - GENERATE REPORTS ON ANY OF THE STATISTICS, WHICH HAVE BEEN FILTERED ON ANY BASIS SUCH AS TO/FROM ADDRESS OR PACKET CONTENTS.

- PROTOCOLS SUPPORTED BY MOST VENDORS INCLUDE SAN, NETBIOS, OS/2 LAN MANAGER, NETWEARE, XNS, TCP/IP, OSI, SNMP, NFS, DECnet, BANYAN VINES, APPLETALK, AND X WINDOWS.

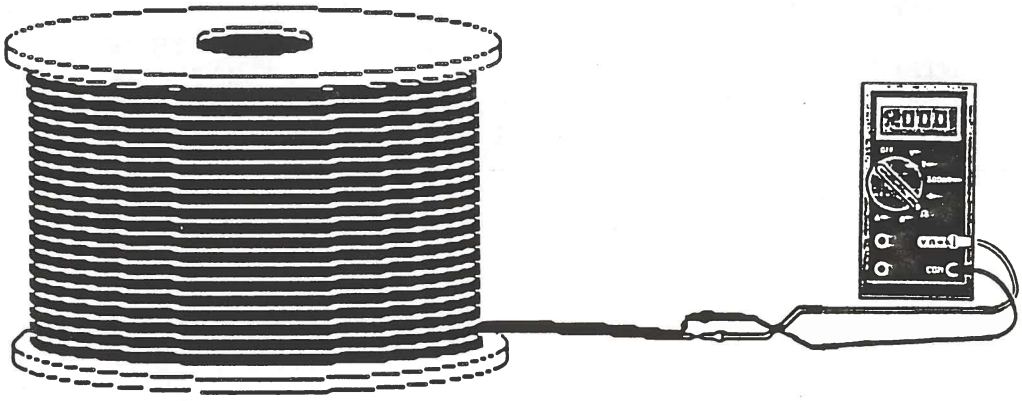
DIAGNOSTIC TOOLS



TWISTED PAIR CABLE CHECKER

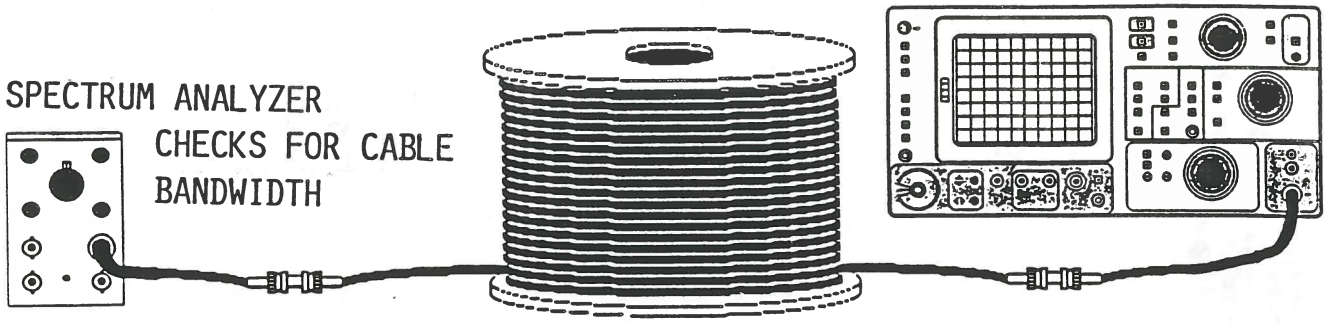


BREAK OUT BOX

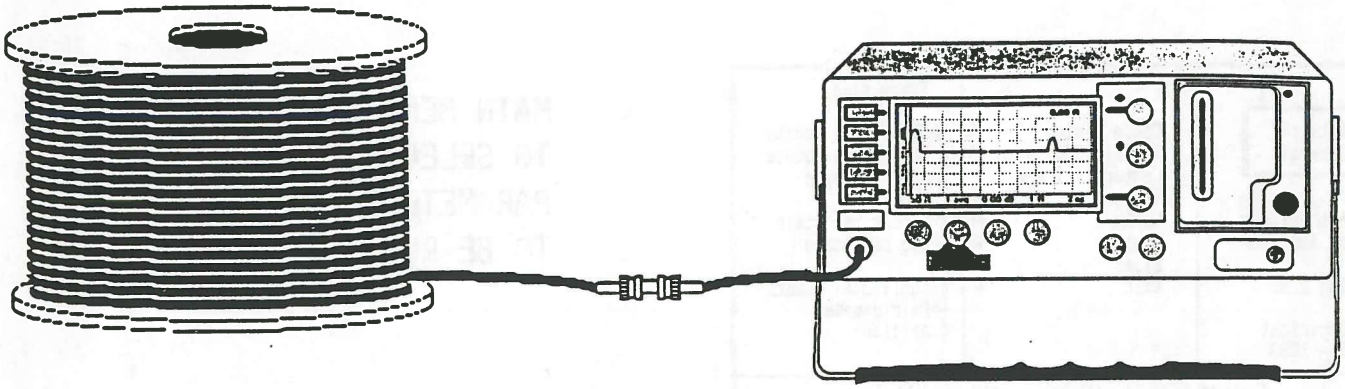


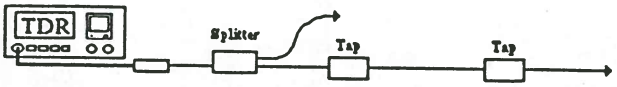
VOM TESTING SPOOL OF CABLE FOR LENGTH (RESISTANCE)

SPECTRUM ANALYZER CHECKS FOR CABLE BANDWIDTH



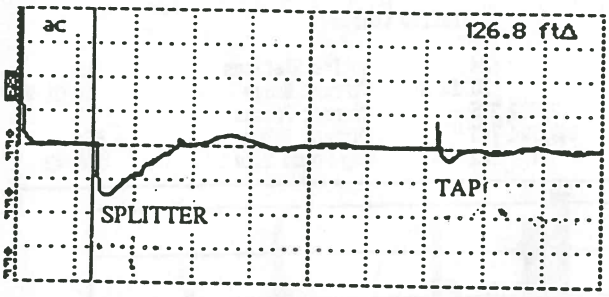
DIAGNOSTIC TOOLS - TIME DOMAIN REFLECTOMETER



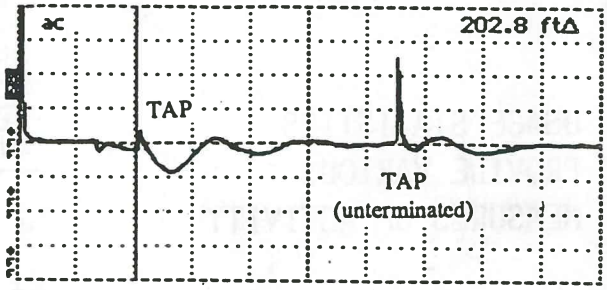


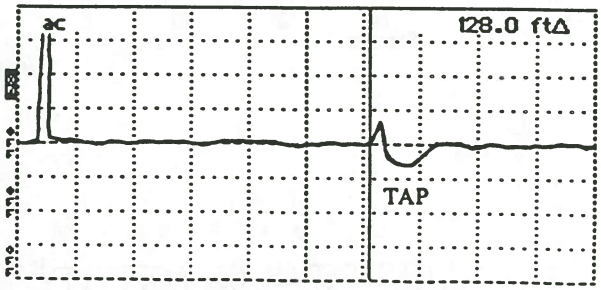
Splitter in Place of Tap.

TDRs CAN IDENTIFY CABLE ATTACHMENTS AND FAULTS USING "RADAR" ECHOS

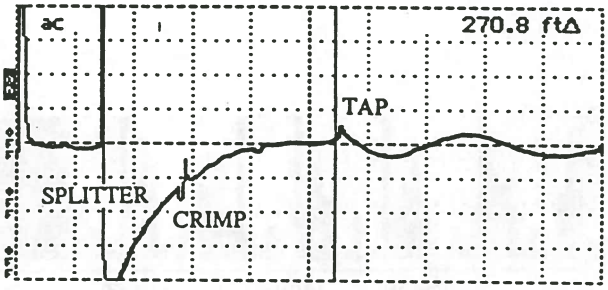


Display of Splitter (one side terminated).

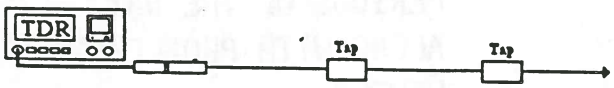




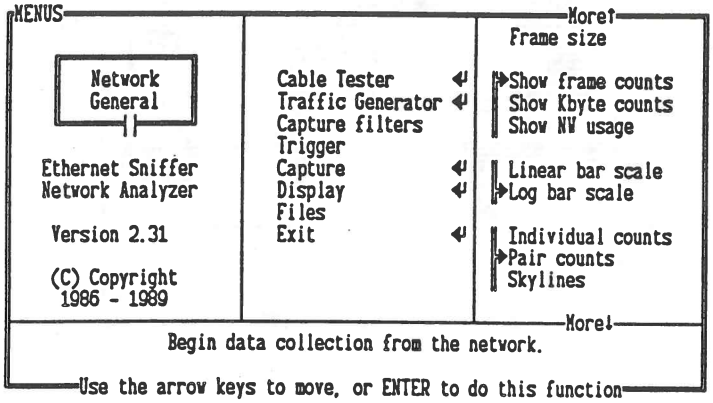
Display of Improved Impedance Match.



Display of Unterminated Splitter.

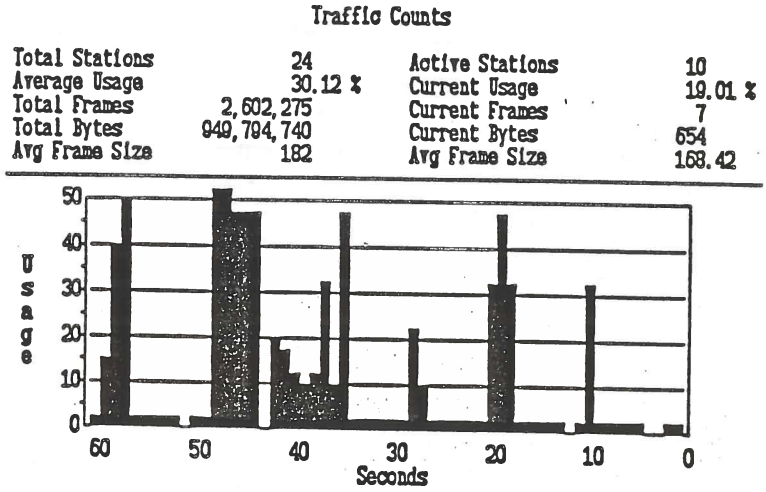


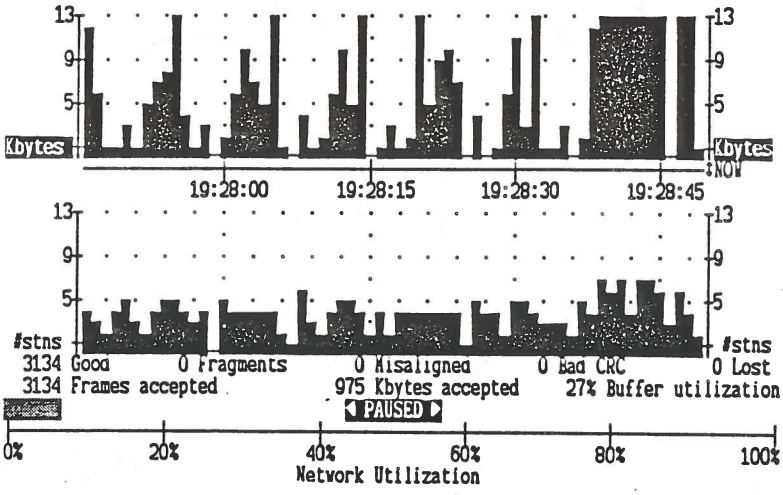
DIAGNOSTIC TOOLS - LAN NETWORK ANALYZER



MAIN MENU SCREEN USED TO SELECT SET UP PARAMETERS AND TESTS TO BE RUN

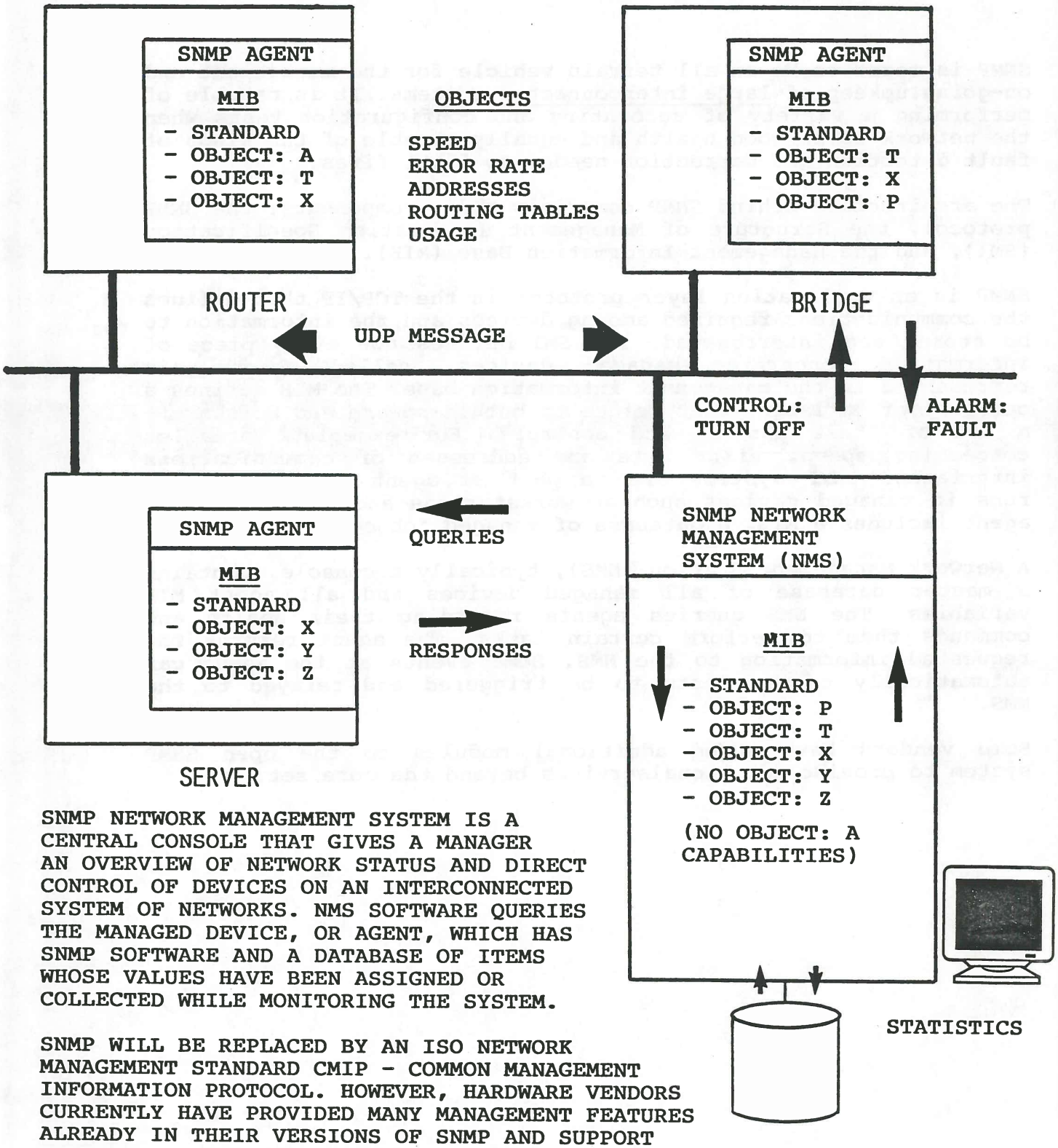
USAGE STATISTICS PROVIDE VARIOUS MEASURES OF ACTIVITY





HISTOGRAM OF ACTIVITY SHOWS USAGE OVER PERIODS OF THE DAY ALONG WITH PROBLEM LEVELS

SNMP - SIMPLE NETWORK MANAGEMENT PROTOCOL



SNMP NETWORK MANAGEMENT SYSTEM IS A CENTRAL CONSOLE THAT GIVES A MANAGER AN OVERVIEW OF NETWORK STATUS AND DIRECT CONTROL OF DEVICES ON AN INTERCONNECTED SYSTEM OF NETWORKS. NMS SOFTWARE QUERIES THE MANAGED DEVICE, OR AGENT, WHICH HAS SNMP SOFTWARE AND A DATABASE OF ITEMS WHOSE VALUES HAVE BEEN ASSIGNED OR COLLECTED WHILE MONITORING THE SYSTEM.

SNMP WILL BE REPLACED BY AN ISO NETWORK MANAGEMENT STANDARD CMIP - COMMON MANAGEMENT INFORMATION PROTOCOL. HOWEVER, HARDWARE VENDORS CURRENTLY HAVE PROVIDED MANY MANAGEMENT FEATURES ALREADY IN THEIR VERSIONS OF SNMP AND SUPPORT ETHERNET, X.25, FDDI, TCP/IP, SOME OSI, DECnet, HDLC, XNS, AND IPX.

SIMPLE NETWORK MANAGEMENT PROTOCOL

SNMP is meant to be an all terrain vehicle for the management and on-going upkeep of large interconnected systems. It is capable of performing a variety of accounting and configuration tests when the network is in good health and equally capable of the kinds of fault detection and correction needed to fight fires.

The architecture behind SNMP comprises three components: the SNMP protocol, the Structure of Management Information Specification (SMI), and the Management Information Base (MIB).

SNMP is an application layer protocol in the TCP/IP that defines the communications required amoung devices and the information to be stored and interrogated. The SMI defines how every piece of information concerning managed devices, called agents, is represented in the management information base. The MIB defines a core set of variables that relate to both hardware and software - a set of "test points" and controls. For example, variables concerning speed, error rate and addresses of communications interfaces. SNMP systems are in part of agent software, which runs in managed devices such as workstations and routers. Every agent includes a MIB, a database of managed "objects".

A Network Management Station (NMS), typically a console, contains a master database of all managed devices and all agent MIB variables. The NMS queries agents regarding their health and commands them to perform certain tasks. The agent returns the requested information to the NMS. Some events at the agent can automatically cause alerts to be triggered and relayed to the NMS.

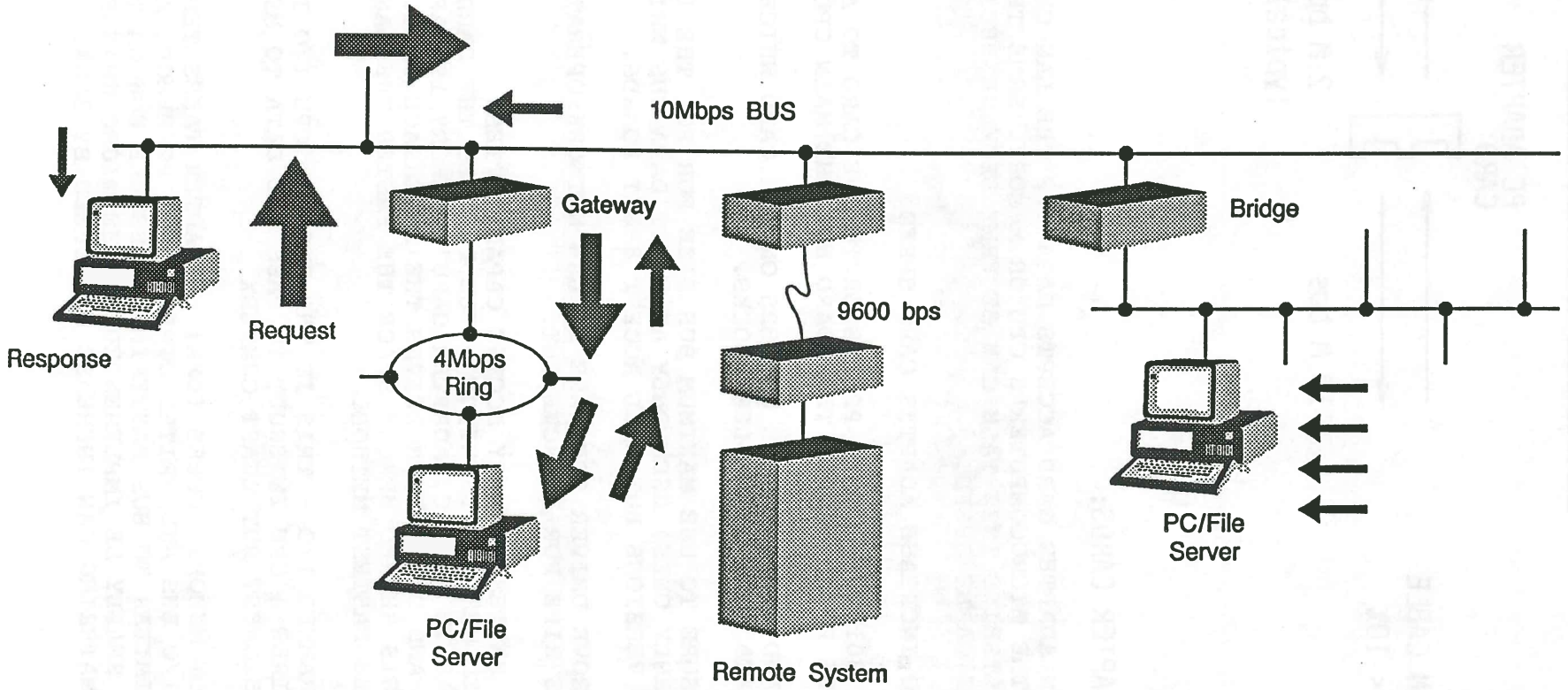
Some vendors have added additional modules to the open SNMP system to provide additionalservices beyond the core set.

LAN Performance Issues

1. PROPAGATION DELAY

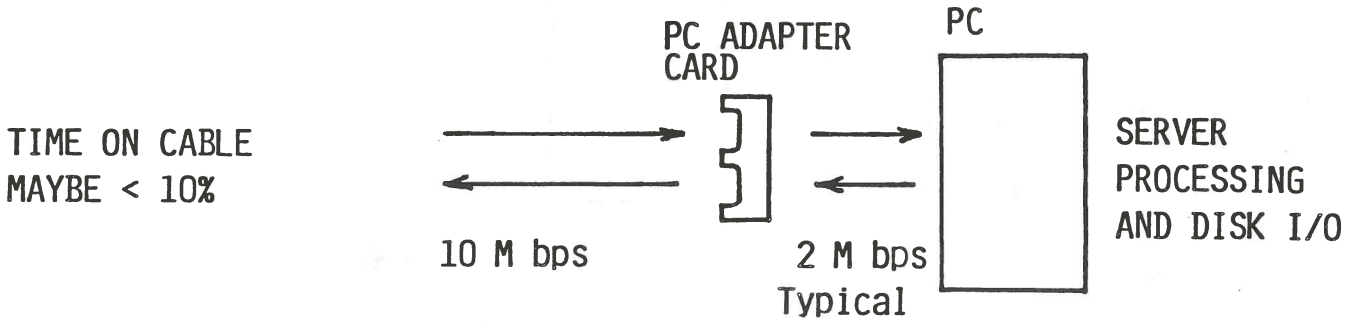
2. FILTERING DELAY

3. NOS/SERVER SERVICE DELAY



4. FAULT/TROUBLE DELAY

LAN PERFORMANCE BOTTLE NECKS



LAN ADAPTER CARDS:

THE LAN ADAPTER CARD ACCEPTS DATA OFF THE LAN CABLE AND PASSES IT TO THE MICROCOMPUTER'S CPU OR MEMORY. SOME TECHNIQUES FOR ACCOMPLISHING THIS TASK CAN BE VERY SLOW, ESPECIALLY RELATIVE TO THE LAN CABLE SPEED.

WAYS TO INCREASE ADAPTER CARD SPEED:

1. ADD 80186 OR OTHER PROCESSOR TO THE CARD TO ALLOW SOME TASKS TO BE PERFORMED ON THE BOARD NOT THE MAIN CPU.

2. EXPAND SEND/RECEIVE BUFFERS ON THE CARD WHICH REDUCES SEGMENTING THE DATA INTO SMALLER BLOCKS.

3. BE SURE TO USE MAXIMUM BUS SIZE FOR PC. THE IBM PC AND XT MODELS (THE EARLY ONES) USED ONLY AN 8-BIT DATA BUS WHILE OTHER MODELS HAVE 16-BIT VERSIONS BUT WILL ACCEPT 8-BIT BOARDS.

4. IMPROVE DRIVER SOFTWARE IN LAN NETWORK OPERATING SYSTEM. THIS AREA IS RIPE FOR IMPROVEMENT.

5. USE FASTEST MEMORY ACCESS CAPABILITIES:
- SHARED MEMORY TECHNIQUE - THE PC USES THE CARD'S MEMORY AS IF IT WAS IN THE PC. ADAPTER CARD'S MEMORY IS MAPPED TO THE PC'S AND DATA NEVER LEAVES THE INTERFACE CARD. THE LARGER THE SIZE OF THIS SHARED MEMORY SPACE THE FASTER THE LAN OPERATION. THIS IS THE FASTEST METHOD.

- PROGRAMMED I/O - THIS IS THE REGULAR CPU I/O INTERFACE WHICH REQUIRES A CPU INTERUPT TO PASS THE DATA TO MEMORY. THIS IS THE SLOWEST BUT LEAST COMPLEX.

- DIRECT MEMORY ACCESS (DMA) - ADAPTER TAKES TEMPORARY CONTROL OF THE I/O BUS AND WRITES DIRECTLY TO PC MEMORY AND NOT USE CPU. THIS IS SIMILAR TO BUS MASTERING. POSSIBLE NOW ON THE PC AT SYSTEMS BUT WILL REALLY BE IMPLEMENTED ON THE MICRO CHANNEL OR EISA TYPE SYSTEMS. BUS MATERING CAN INCREASE I/O SPEED BY 300%.

SECTION 11.

APPENDIX

REFERENCE READING LIST

GENERAL DATA COMMUNICATIONS:

1. Gilbert Held, DATA COMMUNICATIONS: A COMPREHENSIVE APPROACH, 1989, 2nd Ed., Mcgraw-Hill. EXCELLANT BOOK!

2. Kenneth Sherman, DATA COMMUNICATIONS: A USER'S GUIDE, 1989, 3rd Ed., Reston Press (Prentice-Hall). EXCELLANT BOOK!

3. Carl Malamed, DEC NETWORKS AND ARCHITECTURES, 1989, McGraw Hill. VERY GOOD ON DEC COMMUNICATIONS.

4. James Martin and Kathleen Chapman, SNA: IBM'S SOLUTION, 1987, Prentice-Hall. GOOD COVERAGE OF SNA, NOT TOO TECHEE.

5. Gilbert Held, DATA COMMUNICATIONS WITH THE IBM PC SERIES, 1988, John Wiley. GOOD OVERVIEW ON PC COMMUNICATIONS.

MORE TECHNICAL DATA COMMUNICATIONS REFERENCES:

6. Joe Campbell, RS-232: THE SOLUTION, 1984, Sybex Books, Berkeley, CA. GREAT ON TESTING PROCEDURES.

7. John McNamara, TECHNICAL ASPECTS OF DATA COMMUNICATIONS, 1982, Digital Press. LOTS OF DETAIL ON HARDWARE.

8. Robert Ellis, DESIGNING DATA NETWORKS, 1986, Prentice-Hall. SOLID FOR WIDE AREA NETWORK DESIGN, GOOD ON TARIFFS.

9. William Flanagan,THE GUIDE TO T1 NETWORKS - HOW TO BUY, INSTALL AND USE T1 FROM DESKTOP TO DS-3, 3rd Ed., Telecom Library (1-800-LIBRARY). SUPER EXPLANATIONS OF T1.

10. Gabriel Kasperek, TROUBLE SHOOTING THE DATA COMMUNICATIONS NETWORK, 1984, Carnegie Press, CA. TO THE POINT, NO FLUFF.

LOCAL AREA NETWORK LITERATURE:

11. Aaron Brenner, OS/2 LANS, LAN Magazine Bookstore/Telecom Library (1-800-LIBRARY). A MUST READ FOR LAN PLANNERS.

12. James MArtin and Kathleen Chapman, LOCAL AREA NETWORKS, 1987, Prentice-Hall. WELL WRITTEN GOOD OVERVIEW.

13. Martin Nemzow, KEEPING THE LINK - ETHERNET INSTALLATION AND MANAGEMENT, 1988, McGraw-Hill. THOROUGH ON ETHERNET.

14. Joseph Hammond, Peter O'Reilly, PERFORMANCE OF LOCAL AREA NETWORKS, 1986, Addison-Wesley. VERY TECHNICAL HOW TO.

15. Mark A. Miller, LAN PROTOCOL HANDBOOK, 1990, M&T Publishing Inc. Redwood City, CA. EXCELLANT AND THOROUGH COVERAGE OF THE TOP NETWORK OPERATING SYSTEMS FOR THE AVERAGE GUY.

16. Mark A. Miller, LAN TROUBLESHOOTING HANDBOOK, 1989, M&T Publishing, Redwood City, CA. ANOTHER GREAT BOOK FROM MILLER THAT GETS INTO THE SPECIFICS OF FINDING PROBLEMS. IF YOU RUN A LAN YOU MUST READ BOTH MILLER BOOKS!

17. Donne Florence, LAN - DEVELOPING YOUR SYSTEM FOR BUSINESS, 1989, John Wiley & Sons. NON TECHNICAL APPROACH TO LANS WITH AN EMPHASIS ON UNDERSTANDING HOW YOUR BUSINESS CAN BENEFIT FROM A LAN AND PROCEDURES FOR SELECTING ONE.

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PERIODICALS:

1. LAN Magazine. A monthly easy to read publication for the novice or anyone who must keep up with the big picture.

2. LAN TECHNOLOGY. A monthly with more technical articles written in depth.

3. LAN TIMES. A monthly, large format newsy and informative publication with good information on general and specific topics.

4. PC WEEK. A weekly PC magazine in large format which usually includes lots of LAN material plus lots and lots of PC information, but piles up quickly.

5. BYTE Magazine. A solid monthly PC journal with technical and indepth articles on all facets of PC use including LANs.

6. Data Communications. A monthly magazine dedicated to the entire spectrum of data communications including LANs. The best data com publication in the business.

7. NETWORK WORLD. Similar to Computer World but dedicated to voice and data communications. A newsy weekly that keeps you up to the minute with stories, articles and news releases about what happened last week. Good, but piles up fast.

GLOSSARY OF LAN TERMS

Accounting management — One of the five basic categories of network management defined by the International Standards Organization (ISO). Accounting management assigns costs to the use of network resources by users or groups of users.

Address — A set of numbers identifying the location of a node on the network. Each node on a network must have a unique address.

Application layer — Layer 7 of the Open Systems Interconnection (OSI) protocols. It serves as the window through which applications access communication services, including file-transfer functions, virtual-terminal functions, and electronic-mail functions.

Audit trail — In respect to network management, a system that provides a list of information about connections and disconnections, reasons for these disconnections, and other status and event information for various managed network nodes.

Backbone — The main cable of a network, linking individual network segments.

Bandwidth — A measure of the information capacity of a transmission channel. Strictly speaking, bandwidth is the difference, expressed in hertz (Hz), between the highest and lowest frequencies of the channel.

Baseband — A transmission scheme in which the entire bandwidth, or data-carrying capacity, of a medium (such as a coaxial cable) is used to carry a single digital pulse, or signal, between multiple users. Because digital signals are not modulated, only one kind of data can be transmitted at a time. Contrast with *Broadband*.

Bridge — A device that interconnects local or remote networks no matter what higher level protocols (such as XNS or TCP/IP) are involved. Bridges form a single logical network, centralizing network administration. They operate at the Open Systems Interconnection (OSI) physical and data link layers. See *SEF (Source Explicit Forwarding)* and *STA (Spanning Tree Algorithm)*. Contrast with *Router*, *Brouter*, and *Gateway*.

Broadband — A data-transmission scheme in which multiple signals share the bandwidth, or data-carrying capacity, of a medium. This allows the transmission of voice, data, and video signals over a single medium, such as a coaxial cable. Cable television uses broadband techniques to deliver several dozen channels over one cable. Contrast with *Baseband*.

Brouter — A device that combines the functions of a bridge and a router. Brouters can route one or more protocols, such as TCP/IP and/or XNS, and bridge all other traffic. Contrast with *Bridge*, *Router*, and *Gateway*.

Bus topology — The network pattern in which all nodes share a single channel. Contrast with *Mesh topology*, *Ring topology*, and *Star topology*.

CCITT	The Comité Consultatif International Télégraphique et Téléphonique, or International Telephone and Telegraph Consultative Committee. It defines standards (such as the X.25 standard) and makes recommendations for international networking.
Circuit switching	A switching technique in which an information path (circuit) between calling and called stations is established on demand for exclusive use by the connected parties until the connection is released. Contrast with *Packet switching*.
CMIP/CMIS (Common Management Information Protocol/Services)	An OSI-based protocol that provides standard ways to manage large multivendor networks.
CMOT (CMIP over TCP/IP)	An Internet standard defining the use of CMIP (an OSI-based protocol) over TCP for managing TCP/IP networks.
Coaxial cable	A transmission medium with a central single-wire conductor surrounded by a concentric layer of insulation, a sheath of wire around the insulation, and an outer shield to protect the cable from electromagnetic and radio frequency interference (EMI/RFI). Two types of coaxial cable—known as "thick" and "thin" for their respective diameters—are used in Ethernet data transmission.
Communications server	A hardware and software product that allows devices such as terminals, host computers, or printers to access a network without having to implement a communications protocol themselves. Instead, the communications server provides the implementation for them.
Configuration management	One of the five basic categories of network management defined by the International Standards Organization (ISO). Configuration management monitors the physical and logical state of the network as well as applications and services. A function of configuration management is to keep an inventory of network resources and their operating parameters, which set the operating conditions for the network.
Connection	A communications path between two devices. A connection allows the exchange of information; equivalent terms are *session* and *circuit*.
CRC (Cyclical Redundancy Check)	A method of detecting errors in a message by performing a mathematical calculation on the bits in the message and then sending the results of the calculation with the message. The receiving station performs the same calculation on the message data it receives and then checks the results against those transmitted at the end of the message. If the results do not match, the receiving station ask the sending station to send the message again.
Datagram	A packet of computer-generated information that includes a complete destination address provided by the user, not the network, along with whatever data the packet carries.

GOSIP (Government) OSI Profile)	The U.S. government's version of the OSI protocols. GOSIP compliance is scheduled as a requirement in government networking purchases.
HDLC (High-level Data Link Control)	A protocol defined by the International Standards Organization and used in X.25 communications. Various manufacturers have proprietary versions of HDLC, including IBM's SDLC.
High-level protocol	A protocol that operates at the network layer and above of the Open Systems Interconnection (OSI) protocols. A high-level protocol carries out functions beyond transporting streams or blocks of data. For example, a high-level protocol can reliably transmit data, format data, establish a connection, and transfer a file.
IEEE 802.2	A data link layer standard used with IEEE (Institute of Electrical and Electronics Engineers) 802.3, 802.4, and 802.5 standards.
IEEE 802.3	A physical layer standard specifying a LAN that uses the carrier-sense multiple access with collision detection (CSMA/CD) access method on a bus topology. Ethernet LANs follow the 802.3 standard.
IEEE 802.4	A physical layer standard specifying a LAN that uses the token passing access method on a bus topology. Manufacturing Automation Protocol (MAP) LANs follow the 802.4 standard.
IEEE 802.5	A physical layer standard specifying a LAN that uses the token passing access method on a ring topology. IBM's Token Ring products follow the 802.5 standard.
Internet	A collection of networks and gateways including ARPAnet (Advanced Research Project Agency Network), MILnet (Military Network), and NSFnet (National Science Foundation Network). Internet uses TCP/IP protocols and functions as a single virtual network.
Internetworking	The connection of two or more networks so that nodes on both can communicate.
IPX (Internetwork Packet eXchange)	A protocol that allows communication in a NetWare® network.
ISO (International Standards Organization)	An independent international body formed to define standards for multivendor network communications. Its seven-layer OSI protocols specify how different vendors' products communicate with each other across a network.
LAN (Local Area Network)	An assembly of computing resources within a certain geographic area. LAN resources can include PCs, printers, minicomputers, and mainframes linked by a common transmission medium such as a coaxial cable or twisted-pair wiring.
LAT (Local Area Transport)	A DECnet protocol used for terminal-to-host communications.

Data-link control (DLC) protocols — A set of rules used by two network nodes, or stations, to perform an orderly exchange of information over the network. A data link includes the physical transmission medium, the protocol, and associated devices and programs, so it is both physical and logical.

Data link layer — Layer 2 of the Open Systems Interconnection (OSI) protocols. It is responsible for getting data packaged and onto the network cable. It also manages the flow of the data bit stream into and out of each network node.

DECnet® — A communications protocol and line of networking products from Digital Equipment Corporation (DEC®). DECnet is compatible with Ethernet and a wide range of systems.

Ethernet — A data link protocol that specifies how data is placed on and retrieved from a common transmission medium. Ethernet has become an IEEE standard. Ethernet is used as the underlying transport vehicle by several upper-level protocols, including TCP/IP and XNS.

Fault management — One of the five basic categories of network management defined by the International Standards Organization (ISO). Fault management is used for the detection, isolation, and correction of faults on the network.

FDDI (Fiber-optic Data Distribution Interface) — A LAN technology that permits 100-megabit-per-second (Mbps) data transfer. FDDI is proposed as American National Standards Institute (ANSI) standard X3T9.5.

Fiber-optic cable — A transmission medium that uses glass or plastic fibers, rather than copper wire, to transport data or voice signals. Information is imposed on the glass fiber via pulses (modulation) of light from a laser or a light-emitting diode (LED). Because of its high bandwidth and lack of susceptibility to interference, fiber-optic cable is employed in long-haul or noisy applications.

Filter — See *Packet filter*.

Flow control — A hardware or software mechanism employed in data communications to turn off the transmission when the receiving station is unable to store the data it is receiving.

Frame — A group of bits that make up an elementary block of data to be sent over a communications channel. Usually, a frame contains its own control information, including the transmission address and data for error detection.

Gateway — A device that interconnects networks having totally different communications protocols. The gateway uses protocol-conversion techniques that translate one set of protocols to another, for example, from TCP/IP to SNA® or from TCP/IP to X.25. A gateway operates at Open Systems Interconnection (OSI) layers up through the session layer. Contrast with *Bridge*, *Router*, and *Brouter*.

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Link layer	Layer 2 of the Open Systems Interconnection (ISO) protocols, also known as the data link layer. It provides an interface to the physical layer from all higher OSI layers. See *Data link layer*.
Logical Link Control (LLC)	An upper sublayer of the data link layer, layer 2 of Open Systems Interconnection (OSI) protocols.
Media	Physical carriers of a network's transmission signals. Network media include coaxial cable, twisted-pair wiring, and optical fiber. ("Media" is the plural of "medium").
Media access control (MAC)	A method for controlling access to a transmission medium such as coaxial cable. Ethernet's carrier sense multiple access with collision detection (CSMA/CD) and token ring's token passing are two widely used media access methods.
Mesh topology	The network pattern in which there are two or more pathways to each node. Contrast with *Bus topology*, *Ring topology*, and *Star topology*.
Network	Communications paths and the computers, terminals, and other devices they interconnect.
Network architecture	The overall design of a communications system. The architecture provides standards for network hardware, software, protocols, access methods, and topology.
Network layer	Layer 3 of the Open Systems Interconnection (OSI) protocols. It establishes connections for communication between two nodes.
Network management	The overseeing and maintaining of a network. See *Accounting management*, *Configuration management*, *Fault management*, *Performance management*, and *Security management*.
Network topology	The pattern of connections among devices on the network.
Node	A point of connection on a network, especially a point at which a terminal or PC is located.
OSI (Open Systems Interconnection)	A seven-layer set of data communications protocols developed by the International Standards Organization (ISO). See *Physical layer*, *Data link layer*, *Network layer*, *Transport layer*, *Session layer*, *Presentation layer*, and *Application layer*. Contrast with *XNS* and *TCP/IP*.
Packet	A group of binary digits, including data and control information, sent in a well-defined format over a network.
Packet filter	A feature of a bridge that compares each packet received with specifications set by the network administrator. If the packet matches the specifications, the bridge can either forward or reject it. Packet filters let the administrator limit protocol-specific traffic to one network segment, isolate electronic mail domains, and perform many other traffic control functions.

Packet switching — The internal operation of a communications network that uses software to dynamically route packets from a source to a destination. Packet switching allows the sharing of a single communications channel among several connections. Contrast with *Circuit switching*.

PAD (Packet Assembler/ Disassembler) — A facility that lets asynchronous terminals access the packet switching technology of a PDN.

PDN (Public Data Network) — A data communications network whose services are publicly available. Typically, a PDN uses packet switching technology.

Performance management — One of the five basic categories of network management defined by the International Standards Organization (ISO). Performance management measures the utilization of network resources to optimize resource use and to predict when new resources will be needed.

Physical layer — Layer 1 of the Open Systems Interconnection (OSI) protocols. It defines the wires and signals that transmit raw data across the network. This layer carries the signals for all higher OSI layers.

Presentation layer — Layer 6 of the Open Systems Interconnection (OSI) protocols. It manages data formats, converting data from one format to another according to application requirements.

Propagation delay — The time necessary for a signal to travel from one point on a circuit to another.

Protocol — A set of rules that precisely define procedures and message format to allow devices on a network to communicate.

Repeater — A network component that regenerates digital signals, thus extending network length. A repeater can interconnect a variety of media such as thick and thin coax. It operates at the Open Systems Interconnection (OSI) physical layer.

Ring topology — The network pattern in which each node is connected to the next to form a complete loop, or ring, and messages travel around the ring. Contrast with *Bus topology*, *Mesh topology*, and *Star topology*.

Router — A device that interconnects local or remote networks using one or more specific protocols such as XNS or TCP/IP. It provides separate administrative domains for each network segment. Routers operate at the Open Systems Interconnection (OSI) layers up through the network layer. Contrast with *Bridge*, *Brouter*, and *Gateway*.

Security management — One of the five basic categories of network management defined by the International Standards Organization (ISO). Security management prevents the misuse of network resources by means of user authorization, access control, and data encryption.

SEF (Source Explicit Forwarding)	A security feature that permits only packets from specified stations to be forwarded across a bridge. By using SEF, an administrator can control access to resources on a network segment.
Session layer	Layer 5 of the Open Systems Interconnection (OSI) protocols. It establishes and terminates network communications between applications.
SNA (Systems Network Architecture)	IBM®'s proprietary network protocol suite. It specifies how IBM mainframes communicate hierarchically with unintelligent peripherals, such as terminals and printers.
SNMP (Simple Network Management Protocol)	The network monitoring function provided by TCP/IP.
STA (Spanning Tree Algorithm)	A technique based on an IEEE 802.1 standard that detects and eliminates logical loops in a bridged network. When multiple paths exist, STA lets a bridge use only the most efficient one. If that path fails, STA automatically reconfigures the network so another path becomes active, sustaining network operations.
Star topology	The network pattern in which nodes are connected individually to a common device, such as a concentrator, which acts as a focal point for network cabling. Contrast with *Bus topology*, *Mesh topology*, and *Ring topology*.
Subnet	A portion of a network that is partitioned by a router.
T1 carrier	A digital transmission system, developed by AT&T, that sends information at 1.544 megabits per second. T1 links can transmit voice or data.
TCP/IP (Transmission Control Protocol/ Internet Protocol)	A layered set of communications protocols originally developed by the Advanced Research Projects Agency (ARPA) of the U.S. Department of Defense. TCP/IP protocols provide Telnet terminal emulation, FTP file transfer, and other services for communication among a wide variety of computer equipment. Further development of TCP/IP standards is an Internet responsibility. See *Internet*. Contrast with *XNS* and *OSI*.
Thin Ethernet	A lighter (0.2-inch diameter, black coating) variation of Ethernet cable that saves cable and installation cost, but is restricted in effective transmission distance. This type of cabling is specified under the IEEE 802.3 10BASE2 standard.
Token ring	A technology developed by IBM that uses a token to control data on the network. There is only one token on the ring (the network) at a time. It is either free or busy. A node must wait for a free token to transmit data; it marks the token as busy and then transmits a frame of data onto the ring. Data collisions cannot occur because only one node can transmit at a time.
Topology	The pattern of physical and logical links among nodes on a network. See *Bus topology*, *Mesh topology*, *Star topology*, and *Ring topology*.

Transport layer Layer 4 of the Open Systems Interconnection (OSI) protocols. It structures messages for transmission over the network by splitting the messages for sending and reassembling them as they are received. The transport layer also provides recovery from transmission errors.

Twisted pair A form of wiring commonly used for telephone installations. Standard networks such as Ethernet can operate over such wiring. A 10BASE-T standard for Ethernet transmission over twisted-pair wiring is being formalized as part of the IEEE 802.3 standard.

VAX® The name for a family of computers manufactured by Digital Equipment Corporation (DEC).

Virtual circuit A facility in a packet switching network in which packets passing between a pair of devices are kept in sequence. This is a "virtual circuit" because it resembles an actual point-to-point connection.

WAN (Wide Area Network) A network covering a large geographic area. The network may include packet-switched, public data, and value-added networks.

X.25 The CCITT designation for a standard interface for packet-switching data-communications networks. X.25 networks employ virtual circuits for end-to-end connections, in contrast to TCP/IP networks, which use datagrams. The X.25 standard is designed to let mainframes access a public or private packet switching network.

X.400 The CCITT designation for an international electronic mail distribution system.

XNS (Xerox Network Systems) A Xerox-developed set of communications protocols designed to run on Ethernet networks. The XNS internetwork datagram protocol provides standards for network layer communications, and the sequenced packet protocol provides standards for the transport layer. Contrast with *TCP/IP* and *OSI*.

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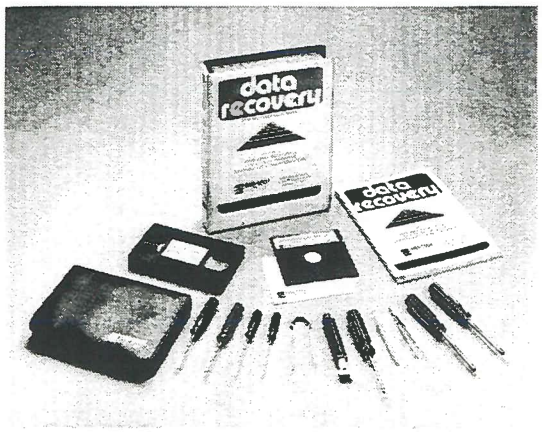

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